ANNUAL HISTORICAL REPORT
CALENDAR YEAR 1987

U S ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

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UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

ANNUAL HISTORICAL REPORT - AMEDD ACTIVITIES

RCS MED-41 (R4)

U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

NATICK, MASSACHUSETTS 01760

CALENDAR YEAR 1987

USARIEM
CY87

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GENERAL INFORMATION

ORGANIZATION

The United States Army Research Institute of Environmental Medicine (USARIEM) is organized with an Office of the Commander/Scientific Technical Director, seven Research Divisions and a Research Support Division consisting of five functional Branches. Organizational chart of USARIEM, dated 1 October 1987 is attached as Appendix A.

LOCATION

USARIEM is located at the United States Army Natick Research Development and Engineering Center (USANRDEC), Natick, Massachusetts 01760.

ACTIVATION AND ASSIGNMENT

a. By Section VI, General Order 33, Headquarters, Department of the Army, 20 September 1961, USARIEM was established as Class II activity under the jurisdiction of The Surgeon General, effective 1 July 1961.

b. General Order No. 40, Department of the Army, Office of Surgeon General, 1 December 1961, assigned USARIEM to the United States Army Medical Research and Development Command, Washington,

c. The USARIEM was last reorganized under General Order No. 32, Department of the Army, Headquarters, U.S. Army Medical Research and Development Command on 1 August 1975.

TENANCY

a. USARIEM is a tenant on the USANRDEC installation and receives administrative and logistical support form the USANRDEC on a reimbursable basis in accordance with an annually renewed intra-Service support agreement.

b. The Pikes Peak Laboratory Facility, Colorado, is a subordinate activity of the USARIEM and is utilized on a seasonal basis when a research requirement exists.

MISSION

Conducts research on the effects of temperature, altitude, work and nutrition on the health and performance of the individual soldier and combat crews operating Army systems. Assesses decrements to soldier or combat crew performance caused by the synergy of environmental extremes protective measures used in NBC sustained operations. Conducts research on the biomedical processes limiting physical performance to determine physical fitness requirements and seek solutions to medical problems related to physical training and exercise. Defines the complex interaction of environmental/operational stress and Army systems and develops, evaluates and assists in the implementation of strategies designed to protect the soldier and enhance performance. In coordination with the Natick Research, Development & Engineering Center (Natick) and through liason with other Federal agencies, conducts research to develop the technology base required to evaluate feeding strategies for operation rations and supplements to minimize soldier performance decrements under sustained combat conditions and discharge the Army Surgeon General's responsibilities as DOD executive agent for nutrition. Assists Natick in the development of personal clothing and equipment by assessing the physiological impact of these items under all climatic conditions. Provides technical advice and consultant services to Army commanders, installations and activities in support of the Army Preventive Medicine Program and, on request to other Federal agencies.

USARIEM
CY87

PERSONNEL

STRENGTH AS OF: 31 December 1987

CIVILIANS	AUTHORIZED	ACTUAL
SES	1	1
GM	7	7
GS	82	69
WG	2	2
TPT	2	15
	94	94

OFFICERS	AUTHORIZED	ACTUAL
MC	5	4
MS	12	12
VC	2	2
	19	18

ENLISTED	AUTHORIZED	ACTUAL
	53	54

TOTAL	AUTHORIZED	ACTUAL
	166	166

KEY STAFF AS OF 31 DECEMBER 1987

David D. Schnakenberg, COL, MS, Ph.D., Commander and Scientific/Technical Director

Richard G. Allen, MAJ, MS, Ph.D., Executive Officer and Director, Research Support Division

Richard W. Weringo, MSG, Chief Medical NCO

James A. Vogel, Ph.D., Director, Exercise Physiology Division

Kent B. Pandolf, Ph.D., Director, Military Ergonomics Division

Richard R. Gonzalez, Ph.D., Chief, Biophysics Branch, Military Ergonomics Division

Michael N.Sawka, Ph.D., Chief, Physiology Branch, Military Ergonomics Division

Roger W. Hubbard, Ph.D., Director, Heat Research Division

Allen Cymerman, Ph.D., Director, Altitude Research Division

Murray P. Hamlet, D.V.M., Director, Cold Research Division and Acting Chief, Cold Injury Branch

Wilbert D. Bowers, Ph.D., Chief, Experimental Pathology Branch, Cold Research Division

Andre A. Darrigrand, MAJ, VC, D.V.M., Chief, Animal Care Branch, Cold Research Division

Eldon W. Askew, LTC, MS, Ph.D., Director, Military Nutrition Division

Terry M. Rauch, MAJ, MS, Ph.D., Director, Health and Performance Division

RESEARCH SUPPORT DIVISION:

John P. Cusack, CPT, MS, Adjutant
Carol A. Joriman, 1LT, MS, Chief, Information Management Branch
Deborah A. Gilbertson, CPT, MS, Chief, Logistics Branch, Detachment Cmdr
John M. Foster, Chief, Bio-Engineering Branch
Marie E. Stephens, Personnel/Manpower, Resource Management Branch
Violet M. Trainer, Program & Budget, Resource Management Branch

ALLOCATION AND FUNDING

USARIEM - FY1987 PROGRAM

DA PROJECT NO. & TITLE	FUNDS
3A161101A91C - In-House Laboratory Independent Research	$ 54,000
3M161102BS10 - Research on Military Disease, Injuries and Health Hazards	1,446,000
3E162777A3GL - Administration and Management	1,944,000
3M162734A875 - Medical Defense Against Chemical Agents	152,000
3E162777A878 - Health Hazards of Military Materiel	434,000
3E162777A879 - Medical Factors Enhancing Soldier Effectiveness	1,371,000
3M263763D819 - Non System Medical Materiel Development - Medical Protection Using Nutrition	372,000
3M263764D995 - Med/Chem Life Support Mat.	711,000
3M463751D993 - Medical Defense Against Chemical Warfare	45,000
Total FY87 Program	$ 6,529,000

SUPPLY AND MAINTENANCE ACTIVITIES

During CY87 a total of 1,807 requests were processed by the Logistics Branch as indicated below:

Non-Expendables - 440 Requests

Expendables - 1,407 Requests

During CY87 the Logistics Branch processed 270 requests for 351 items of excess equipment, representing $388,823.44.

During CY87, the Medical Maintenance Section used a total of 1840.6 hrs to maintenance medical equipment. A breakdown of maintenance hours is listed below:

Scheduled Services: 817.7 hrs
Unscheduled Services: 922.9 hrs

There were 417 items processed for calibration.

BUILDING AND FACILITY EQUIPMENT

INSTRUMENTATION DESIGN AND DEVELOPMENT:

The Bioengineering Branch contributed to the design and development of the following for the period, CY87:

a. Handwear contact simulator to measure heat transfer from the hand in a standardized procedure.

b. Upper extremity movement analyzer to measure neuromuscular reaction.

c. Initiated development of in-shoe activity/recording device to measure soldier activity levels in the field.

d. Initiated artifical horizon visual disturbance apparatus as a device to predict sensitivity to altitude exposure.

e. Self-paced biofeedback tachometer for superbike.

BUILDING MODIFICATIONS:

a. Main entrance security card key stystem was installed.

b. Initiated $100,00 request to upgrade power transformer to meet Institute power demands.

OFFICE OF THE COMMANDER

PUBLICATIONS:

Banderet, L.E., H.L. Lieberman, R.P. Francesconi, B.L. Shukitt, R.F. Goldman, D.D. Schnakenberg, T.M. Rauch, P.B. Rock and G.F. Meadors, III. Development of a paradigm to assess nutritive and biochemical substances in humans: A preliminary report on the effects of tyrosine upon altitude-and cold- induced stress responses.NATO AGARD Conference Proceedings, No 415: Biochemical Enhancement of Performance, Loughton, Essex: Specialized Printing Services Limited, pp 3-1 to 3-12, 1987.

Carlson, D.E., T. Dugan, J.C. Buchbinder, J. Allegretto and D. D. Schnakenberg. Nutritional assessment of the Ft. Riley non-commissioned officer academy dining facility. USARIEM Technical Report No. T/14, 1987.

Francesconi, R., R. Hubbard, P. Szlyk, D. Schnakenberg, D. Carlson, N. Leva, I. Sils, L. Hubbard, V. Pease, J. Young and D. Moore. Urinary and hematologic indices of hypohydration. J. Appl. Physiol. 62:1271-1276,1987.

West, L.L. and D.D. Schnakenberg. Independent evaluation report for product improvement program of the meal, ready-to-eat. USATECOM/USARIEM Report, January 1987.

ABSTRACTS:

Schnakenberg, D., D. Carlson, S. Deems,R. Popper and E. Hirsch. Validation of a Visual Observation Method for Nutritional Evaluation of Food Service Systems for Military Populations. Fed. Proc. 46(3):875, 1987.

PRESENTATIONS:

Sammonds, K., T. Dugan, M. Sawyers, C. Walsh, B. Wenzinger, and D.D. Schnakenberg. Recent advances in computerized technologies for dietary assessment of military populations. Invited presentation to Third Conference for Federally Supported Human Nutrition Research Units and Centers, Bethesda, MD, 24-25 March 1987.

Schnakenberg, D., D. Carlson, S. Deems, R. Popper, and E. Hirsch. Description and Validation of New Dietary Methodologies for Nutritional Evaluation of Military Rations and Food Service Systems. Invited Presentation to Third Conference for Federally Supported Human Nutrition Research Units and Centers, Bethesda, MD, 24-25 Feb 1987.

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KEY BRIEFINGS:

David D. Schnakenberg, COL, MS, Ph.D., Presented briefing on DoD Nutrition Research Actvities at Quarterly Meeting of the Interagency Committee on Human Nutrition Research, Washington, DC, 14 Jan 1987.

David D. Schnakenberg, COL, MS, Ph.D. - Present independent evaluation of medical/nutritional results of Nov, 1986, Improved Meal Ready to Eat (MRE) Test to the Army Materiel Command (AMC) Materiel Acquisition Review Board (MARB), Alexandria, VA, 22 Jan 1987.

David D. Schnakenberg, COL, MS, Ph.D. - Present independent evaluation of medical/nutritional results of Nov 1986, Improved MRE test to HQDA General Officer In-Process Review (IPR), Penatagon, Washington, DC, 29 Jan 1987.

David D. Schnakenberg, COL, MS, Ph.D. - Present proposal for 18 manpower spaces for USARIEM Military Nutrition Division to HQDA Out of Cycle Manpower Committee, Pentagon, Washington, DC, 27 Mar 1987.

David D. Schnakenberg, COL, MS, Ph.D. - Served as Chairman, 5th meeting of Research Study Group 8, Nutritional Aspects of Military Feeding, NATO Panel Meeting, Brussels, Belgium, 7 April 1987.

David D. Schnakenberg, COL, MS, Ph.D. - Present review and analysis of USARIEM'S FY87 Research Program to USAMRDC Research Area Director III, COL Lam and Staff, Ft Detrick, MD, 2 Apr 1987.

David D. Schnakenberg, COL, MS, Ph.D.. Present invited lecture on "Battlefield Nutrition Issues" at Preventive Medicine Officers Symposium, WRAIR, Washington, DC, 19 May 1987.

David D. Schnakenberg, COL,MS, Ph.D. Present briefing "Soldier Products from USARIEM Research" at Soldier Performance Research and Analysis Review (SPRAR) chaired by LTG Elton, DCSPER at Ft. Belvoir, 29 May 1987.

David D. Schnakenberg, COL, MS, Ph.D. Present briefing to defend proposal for 18 Manpower spaces for USARIEM Military Nutrition Division to HQDA Force Structure Integration Conference at Ft. Belvoir, VA, 23-24 Sep 1987.

David D. Schnakenberg, COL, MS, Ph.D. Present briefing on USARIEM's Military Nutrition Research Program to DoD Nutrition Committee meeting, Pentagon, Washington, DC, 15 Oct 1987.

David D. Schnakenberg, COL,MS, Ph.D., Present and defend a proposal for a $ 3.5M Ration Testing Program FY90-94 Management Decision Package(MDEP) before HQDA Sustain Panel, Pentagon, Washington, DC, 14 Dec 1987.

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SIGNIFICANT TDY:

David D. Schnakenberg, COL - Attend Workshop on Calorie Dense Diets. Sponsored by NAS/NRC Committee on Military Nutrition Research, Washington, DC, 12-13 Feb 1987.

David D. Schnakenberg, COL - Attend USAMRDC Commander's Conference and Medical System Review Committee meeting, Fitzsimmons Army Medical Center, Denver, CO, 15-18 Feb 1987.

David D. Schnakenberg, COL - Participate in Joint Working Group Meeting No. 7 on Feeding the Army at FT. Lee, VA, 24 Mar 1987.

David D. Schnakenberg, COL - Participate in Lightening the Soldier's Load Technology Demonstration Steering Committee meeting at FT. Benning, GA, 17 June 1987.

David D. Schnakenberg, COL - Participate in Joint Working Group meeting No. 8 on Feeding the Army at FT Lee. VA, 25 Jun 1987.

David D. Schnakenberg, COL - Participate in Joint USAF and Navy Medical R & D Command Sponsored Conference on Effects of G-Forces on Performance, Naval Aerospace Medical Research Laboratory, Pensacola Naval Air Station, FL, 21-22 Jul 1987.

David D. Schnakenberg, COL - Paticipate in the U.S. Army Nuclear Chemical Agency sponsored meeting on Effects of Wearing Individual Protection Equipment on Performance, Arlington, VA, 6 Jul 1987.

David D. Schnakenberg, COL - Represent DoD at quarterly meeting of Interagency Committee on Human Nutrition Research, Washington, DC, 17 Jul 1987.

David D. Schnakenberg, COL - Participate in Joint Working Group Meeting No. 9 on Feeding the Army at FT. Lee, VA, 21 Sep 1987.

David D. Schnakenberg, COL - Represent DoD at Quarterly meeting of Interagency Committee on Human Nutrition Research, Washington, DC, 2 Oct 1987.

David D. Schnakenberg, COL - Participate in Lightening the Soldier's Load Technology Demonstration Steering Committee meeting at FT Benning, GA, 14 Oct 1987.

David D. Schnakenberg, COL - Attend briefing by LTC Askew on USARIEM's Military Nutrition Research Program to LTG Quinton Becker, The Surgeon General of the Army, Falls Church, VA, 16 Oct 1987.

David D. Schnakenberg, COL - Participate in the Lightening the Soldier's Load (LTSL) Technology Demonstration and attend the LTSL Steering Committee meeting at FT Benning, GA, 5-6 Nov 1987.

David D. Schnakenberg, COL - Attend a meeting of Laboratory Commanders and USAMRDC Staff at FT Detrick, MD, 9 Dec 1987.

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SIGNIFICANT VISITORS:

MG James Drummond, CG,USAOTEA, Falls Church, VA, 23 Mar 87.

MG Philip Russell, CG, USAMRDC, FT Detrick, MD, 12-13 May 87.

Dr. Hamed El Bisi, OASARDA, Washington, DC, 22 May 1987.

LTC(P) LeBlanc, Chief Logistics, USAMRDC, FT. Detrick, MD, 13 Jan 1987.

COL Shapiro and MAJ Epstein, Israeli Defense Forces, 22 May 1987.

Dr. Wm Go, Dr. Van Hubbard, Dr. Darlu Danford, National Institute of Health, Bethesda, MD, 4 Sept 1987.

Dr. A. M. Newton, APRE Aldershot, United Kingdom, 20 Nov 1987.

LTC Jean de Hemptinne, Military Hospital, Brussells, Belgium, 9-13 Nov 1987.

MAJ Noah Bennett, National Defence HQs, Ottawa, Canada; 9-13 Nov 1987.

Dr. Ira Jacobs, DCIEM, Toronto, Canada, 9-13 Nov 1987.

MAJ Per Neskleiv, Department of Defense, Oslo, Norway, 9-13 Nov 1987.

COL Torston Gregerson, Department of Defense, Copenhage, Denmark, 9-13 Nov OP1987.

MAJ John Edwards, Army Catering Corps, Aldershot, United Kingdom, 9-13 Nov 1987.

Dr. D.J. Smith, Institute of Naval Medicine, United Kingdom, 9-13 Nov 1987.

COL Erich Sommer, FMDD, Surgeon General Office, Bonn, FRG, 9-13 Nov 1987.

Dr.Brian Farnworth, Defense Research Establishment, Ottawa, Canada, 24 Sep 1987.

MAJ Guy Legault, Defense Research Establishment, Ottawa, Canada 23-24 Sep 1987.

Dr. P. Schutte, Chamber of Mines, Cape Town, South Africa, 19 Jun 1987.

COL Martin Daley, British Medical Liason Officer, Washington, DC, 28-29 Sep 1987.

Dr. Shinfu Sun, Director Tibet Institute of Medical Sciences, Lhasha, Tibetan Autonomous Region, Peoples Republic of China, 17 Feb 1987.

DR. Ji Xiang Chen, Vice-head, Bureau of Public Health Lhasha, Tibetan Autonomous Region, Peoples Republic of China, 17 Feb 1987.

OFFICE OF THE COMMANDER

SIGNIFICANT EVENTS:

Hosted USARIEM "Current Concepts in Environmental Medicine Course". 11-15 May 1987, (18 attendees).

Hosted WRAIR Fellows, 13-14 Oct 1987 (Five attendees).

Hosted meeting of NATO Panel VIII, Research Study Group 8, Nutritional Aspects of Military Nutrition, 9-13 Nov 1987 (8 foreign attendees).

Chronological History of Out-of-Cycle Manpower Request for USARIEM's Military Nutrition Division:

8 Jan 87 - The Office of the Surgeon General (DASG-HCZ) forwarded to the HQDA Deputy Chief of Staff for Personnel (DAPE-MBC) an out-of-cycle (OOC) request for 18 authorizations (5 military, 13 civilian) for a Military Nutrition Research Division at USARIEM. Strong written support provided by Deputy Under Secretary of Army for Operational Research (Mr. Walter Hollis), Deputy Chief of Staff for Logistics (LTG Register), HQS, Army Materiel Command (Mr. Lorber, SES), and Cmdr, Soldier Support Center (COL Tetu).

27 Mar 87 - HQDA OOC committee rejects USARIEM's request because of low priority.

17 Jun 87 - CG, USAMRDC (MG Russell), submitted, with endorsement from The Surgeon General (LTG Becker), an appeal of the OOC committee's disapproval to Vice Chief of Staff Army (VCSA).

26 Jun 87 - VCSA (GEN Brown) overruled the OOC committee and approved the USARIEM manpower request.

14 Sep 87 - Deputy Chief of Staff for Personnel informed Cmdr USARIEM (HQDA MSG, DAPE-MBA-MP, dated 14 Sep 87) that the VCSA had approved the USARIEM's OOC manpower request and that the civilian manpower for FY88/89 and the military manpower for FY89 would be implemented in the FY90 Program Budget Guidance.

24 Sep 87 - COL Schnakenberg successfully defended USARIEM's need for the 18 manpower authorisations for the years FY90 and beyond before the General Officer Steering Committee on Force Structure Integration Conference at FT Belvoir.

28 Sep 87 - Phone call from COL Reichard, Chief of Staff, USAMRDC stating that USARIEM could begin hiring permanent civilians for the Military Nutrition Division on 1 Oct 1987.

27 Oct 87 - Memo from Cmdr, USARIEM to Cmdr, USAMRDC requested an increase in USARIEM's Civilian Employment Level Plan (CELP) and associated Annual Funding Target (AFT) to pay for all authorized civilian manpower spaces.

OFFICE OF THE COMMANDER

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

David D. Schnakenberg, COL, MS, Ph.D. - Chairman, NATO Panel VIII, Research Study Group - 8, Nutritional Aspects of Military Feeding.

David D. Schnakenberg, COL, MS, Ph.D. - DoD Representative to Interagency Committee on Human Nutrition Research.

David D. Schnakenberg, COL, MS, Ph.D. - Member, Steering Group for Lightening the Soldier's Load Technology Demonstration.

David D. Schnakenberg, COL, MS, Ph.D. - Member, Joint Working Group on Feeding the Army.

David D. Schnakenberg, COL, MS, Ph.D. - Member, DoD Nutrition Committee.

ALTITUDE RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Six men were studied during the course of 40-days progressive decompression to 240 Torr, equivalent to the summit of Mt. Everest (Operation Everest II), in order to determine the effects of hypoxia per se on nutrition and body weight loss without the confounding influences present in a real mountain field study. Subjects lost a mean of 7.4 Kg (9% of their initial body weight); caloric intake was reduced 42.3% to 1789 kcal from an initial level of 3136 kcal, despite access to adequate and varied meals. One third of the weight loss was fat and two-thirds was lean tissue, as determined by C-T scans, hydrostatic weighing, and skinfold and body circumference measurements.

Rebreathing devices, designed and tested to produce initial oxygen concentrations of 13.5% (PO_2 = 100 Torr equivalent to 13,000 ft altitude), were evaluated at sea level for their ability to induce altitude acclimatization prior to altitude ascent. The devices were found to meet this standard on day one, but not on successive days when the altitude equivalent dropped to 11,000 ft. Incidence of acute mountain sickness at 15,000 ft was slightly reduced in 12 soldiers using the devices, but the symptom severity was identical to the 10 man control group. Use of the device did not change hematocrit, hemoglobin concentration or plasma volume measurements from control. It was concluded that the ability of the devices to induce altitude acclimatization was marginal at best.

The hyperventilatory response to fatiguing isometric exercise was studied as a predictor of subsequent hyperventilation and acute mountain sickness at 14,110 ft altitude. No relationship was found between the pattern or magnitude of the exercise-induced hyperventilation on successive endurance handgrips and the subsequent severity of acute mountain sickness. Maximum isometric handgrip strength was, however, significantly increased with no overall effect on endurance time. The increase in isometric strength at altitude and on acute return to sea level may be related to the presence of respiratory alkalosis.

In order to determine whether altitude reduces ventilatory muscle endurance, as measured by the capacity for sustained voluntary eucapnic hyperpnea, nine soldiers were studied at sea level and 14,110 ft altitude. No evidence was found to indicate that ventilatory fatigue was a factor in limiting exercise endurance at altitude.

ALTITUDE RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Seven soldiers performed one- and two-legged maximal $\dot{V}O_2$ tests on a cycle ergometer at sea level and 14,110 ft altitude to determine whether the reduction observed in $\dot{V}O_2$ max at altitude is due to a reduction in cardiac output or to an inability of the working muscles to adequately utilize available oxygen. During acute altitude exposure the reductions on both tests were related to the reduction in O_2 content, while with chronic exposure 2-legged maximal $\dot{V}O_2$ remained reduced and one-legged maximal $\dot{V}O_2$ increased in direct proportion to the O_2 content suggesting the limiting role of cardiac output in the reduction of $\dot{V}O_2$ at altitude.

Plasma lipid profiles were examined from six young men participating in Operation Everest II during which they were gradually decompressed to 240 Torr, equivalent to the summit of Mt. Everest. Plasma total cholesterol levels were reduced 25%; and high density lipoprotein cholesterol was reduced 32% with no change in the ratio of the two. Although plasma triglyceride increased 45%, there was no change in free fatty acid levels. Insulin levels were increased 2.2 fold with no change in glucagon. This profile is unlike that associated with weight loss due to fasting and may represent an effect of high altitude that is independent of weight loss due to inadequate dietary intake.

Plasma ammonium concentrations $[NH_4^+]$ were examined in an exercise and a sedentary control group during submaximal exercise at 75% of maximum at sea level and after 13 days residence at 14,110 ft altitude. The active group showed no increase in post-exercise levels whereas the sedentary group showed elevated levels but to a lesser extent than those observed after exercise at sea level or acute altitude exposure. This decrease in $[NH_4^+]$ is associated with, and may contribute to, the enhanced exercise performance and altered substrate utilisation observed with altitude acclimatization.

Sojourners to high altitude experience a metabolic adaptation that spares the utilization of muscle glycogen during comparable levels of exercise. To determine whether beta-adrenergic blockade interferes with this acclimatization effect propranolol was administer to 12 soldiers in a double blind experimental design at sea level and during 20-days exposure to 14,110 ft altitude. The data obtained from muscle biopsy samples obtained during cycle exercise confirm that altitude acclimatization does result in decreased glycogen utilization and that beta blockade did not prevent this adaptation.

ALTITUDE RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

The human hypothalamic-pituitary response to hypoxia was studied after 13 h at a simulated altitude of 15,000 ft. Measured baseline serum levels of prolactin, thyroid stimulating hormone, luteotropic hormone, and follicle stimulating hormone were not significantly different at altitude. Stimulation of prolactin and thyroid stimulating hormone with protirelin and gonadrelin resulted in significantly lower secretion peaks and concentration levels, indicative of the inability of cells in the pituitary to respond to hypothalamic releasing hormones.

The effect of human atrial natriuretic peptide on the renin-angiotensin-aldosterone system during submaximal exhaustive exercise at 14,110 ft altitude was studied to determine its importance in altering known altitude-induced shifts in fluid balance. Analysis of plasma sample pre-, during and post exercise at sea level, one h of altitude exposure, and after 15 days indicated that although atrial natriuretic peptide rose with exercise and acute altitude exposure, there was no effect with chronic exposure nor any correlation with the renin-angiotensin-aldosterone levels.

PUBLICATIONS:

Askew, E.W., I. Munro, M.A. Sharp, S. Siegel, R. Popper, M.S. Rose, R.W. Hoyt, J.W. Martin, K. Reynolds. H.R. Lieberman, D. Engell and C.P. Shaw. Nutritional status and physical and mental performance of special operations soldiers consuming the ration, lightweight, or the meal, ready-to-eat military field ration during a 30-day field training exercise. USARIEM Technical Report No. T/7, 1987.

Burse, R.L., A. Cymerman and A. Young. Respiratory response and muscle function during isometric handgrip exercise at high altitude. Aviat. Space Environ. Med. 58:39-46, 1987.

Devine, J.A. Cooling electronic equipment at simulated high altitude in hypobaric chambers. USARIEM Technical Report No. T/33, 1987.

Devine, J.A. and A. Cymerman. An environmentally-controlled extended-use small animal hypobaric chamber. Aviat. Space Environ. Med. 58:473-476, 1987.

Forte, V., S. Muza, R. Hoyt and A. Cymerman. A plethysmograph for measuring pulmonary ventilation in small animals. USARIEM Technical Report No. T/18, 1987.

ALTITUDE RESEARCH DIVISION

PUBLICATIONS:

Groves, B.M., J.T. Reeves, J.R. Sutton, P.D. Wagner, A. Cymerman, M.K. Malconian, P.B. Rock, P.M. Young and C.S. Houston. Operation Everest II: High altitude pulmonary hypertensive unresponsive to oxygen. J. Appl. Physiol. 63:521-530, 1987.

Huang. S.Y., L.G. Moore, R.E. McCullough, R.G. McCullough, A.J. Micco, C.S. Fulco A. Cymerman, M. Johnson. J.V. Weil and J.T. Reeves. Internal carotid and vertebral arterial flow velocity in man at high altitude. J. Appl. Physiol. 63:395-400, 1987.

Kolka, M.A., L.A. Stephenson, P.B. Rock and R.R. Gonzalez. Local sweating and cutaneous blood flow during exercise in hypobaric environments. J. Appl. Physiol. 62:2224-2229, 1987.

Malconian, M.K., P. Rock, J.A. Devine, A. Cymerman, J.R. Sutton and C.S. Houston. Operation Everest II: Altitude decompression sickness during repeated altitude exposure. Aviat. Space Environ. Med. 58:679-82,1987.

Moore, L.B., A. Cymerman, H. Shao-Yung, R.E. McCullough, R.G. McCullough, P.B. Rock, A.J. Young, P.M. Young, J.V. Weil and J.T. Reeves. Propranolol blocks the increase in resting metabolic rate, but not ventilatory acclimatization to 4300 m. Respir. Physiol. 70:195-204, 1987.

Reeves, J.T., B.M. Groves, J.R. Sutton, P.D. Wagner, A. Cymerman, M.K. Malconian, P.B. Rock, P.M. Young and C.S. Houston. Operation Everest II: Preservation of cardiac function at extreme altitude. J. Appl. Physiol. 63:531-539, 1987.

Reeves, J.T., B.M. Groves, J.R. Sutton, P.D. Wagner, A. Cymerman, M.K. Malconian, P.B. Rock, P.M. Young, J.K. Alexander and C.S. Houston. Oxygen transport during extreme altitude: Operation Everest II. Ann. Emerg. Med. 16:993-998, 1987.

Rock, P.B., T.S. Johnson, A. Cymerman, R. Burse, L. Falk and C.Fulco. Effect of dexamethasone on symptoms of acute mountain sickness at Pipes Peak, Colorado (4,300 m). Aviat. Space Environ. Med. 58:668-672, 1987.

Rose, M.S. C.S. Houston, C.S. Fulco. G. Coates, D. Carlson, J.R. Sutton and A. Cymerman. Operation Everest II: Effects of a simulated ascent to 29,000 feet on nutrition and body composition. USARIEM Report No. T/15, 1987.

Wagner, P.D., J.R. Sutton, J.T. Reeves, A. Cymerman, B.M. Groves and M.K. Malconian. Operation Everest II: pulmonary gas exchange during a simulated ascent of Mt. Everest. J. Appl. Physiol. 63:2348-2359, 1987.

ALTITUDE RESEARCH DIVISION

PUBLICATIONS:

White, D.P., K. Gleeson, C.K. Pickett, J.Y. Reeves, A.M. Rannels, A. Cymerman and J.V. Weil. Altitude acclimatization: influence on periodic breathing and chemoresponsiveness during sleep. J. Appl. Physiol. 63:401-412, 1987.

Young, P.M., P.B. Rock, L.A. Trad, V.A. Forte, C.S. Fulco and A. Cymerman. Altitude acclimatization attenuates plasma ammonia accumulation during submaximal exercise. J. Appl. Physiol. 63:758-764, 1987.

ABSTRACTS:

Burse, R.L. and V. A Fort. Effect of 8-hours breathing of sub-ambient PO_2 for 10 successive days on subsequent acute mountain sickness at 4500 m. Fed. Proc. 46:793, 1987.

Forte, V.A., D.E. Leith, C.S. Fulco, S. Muza, M.K. Malconian, P.B. Rock and A. Cymerman. Ventilatory endurance at altitude. Fed. Proc. 46:1092, 1987.

Forte, V.A., M.K. Malconian, P.B. Rock, P. Young, L.A. Trad, B. Ruscio, J.R. Sutton, C. Houston and A. Cymerman. Operation Everest II: Comparison of four instruments for measuring blood oxygen saturation. The Physiologist 30:194, 1987.

Fulco, C.S., P.B. Rock, L.A. Trad, V. Forte, B. Ruscio, M. Malconian and A. Cymerman. Maximal oxygen uptake ($\dot{V}O_2max$) improves during one- but not two-legged cycling during altitude acclimatization. Fed. Proc. 46:1092, 1987.

Garner, S.H., J.R. Sutton, R. Burse, A.J. McComas, A. Cymerman and C. Houston. Operation Everest II: neuromuscular performance under conditions of chronic hypobaric hypoxia. Med. Sci. Sports Exer. 19:S28, 1987.

Hoyt, R.W., J.M. Egler, E.D. Norcross, M.J. Leskiw, M.D. Schluter and J.P. Stein. Effect of induced metabolic alkalosis on blood lactate kinetics during maximal rowing exercise. The Physiologist 30:131, 1987.

Hoyt, R.W., T.P. Stein, J.M. Egler, M.L. O'Toole and W.B. Hiller. A comparison of the effects of 8 hours of exercise on blood metabolite levels in males and females. Fed. Proc. 46:681, 1987.

Meehan, R., P. Rock, G. Taylor, N. Hunter, T. Mader, N.Cintron and A. Cymerman. Digital image analysis of hypoxia-induced retinal dilation. Aviat. Space Environ. Med. 58:A29, 1987.

ALTITUDE RESEARCH DIVISION

ABSTRACTS:

Rock, P.B., W.J. Kraemer, C.S. Fulco, L.A. Trad, C.D. Cruthirds, V.A. Forte, B.A. Ruscio and A. Cymerman. Endogenous human atrial natriuretic peptide (hANP) does not affect plasma renin activity (PRA) or aldosterone (ALDO) during submaximal exercise at altitude. Fed. Proc. 46:1091, 1987.

Rock, P.B., T.S. Johnson, R.F. Spark, R.F. Larsen, L.A. Trad, C.S. Fulco, and A. Cymerman. Thirteen-hour exposure to 4572m altitude is associated with decreased pituitary response to hypothalamic releasing hormones. 5th International Hypoxia Symposium. Banff, Alberta, Canada, February, 1987.

Rose, M.S., C.S. Houston, C.S. Fulco, G. Coates, D. Carlson and A. Cymerman. Operation Everest II: Nutrition and body composition. Fed. Proc. 46:1334, 1987.

Sutton, J.R., H.J. Green, P.M. Young, A. Cymerman and C.S. Houston. Muscle energetics during ascent to extreme simulated altitude - Operation Everest II. Med. Sci. Sports Exer. 19:S28, 1987.

Trad, L.A., C.S. Fulco, P.B. Rock, B.A. Ruscio, P.M. Young and A. Cymerman. Onset of lactate accumulation during progressive exercise is unaltered after 11 days at altitude. Physiologist 30:195, 1987.

Young, A.J., P.M. Young, P. B. Rock, A. Cymerman, L.G. Moore, and J.T. Reeves. Beta-adrenergic blockade during altitude acclimatization fails to prevent glycogen sparing adaptations in muscle metabolism. Fifth International Hypoxia Symposium, Lake Louise, Canada, February, 1987.

Young, P.M., P.B. Rock, A. Cymerman, and J.R. Sutton. Operation Everest II: effects on plasma cholesterol, triglyceride and free fatty acid metabolism. Fifth International Hypoxia Symposium, Lake Louise, Canada, February, 1987.

Young, P.M., P.B. Rock, A. Cymerman and J.R. Sutton. Operation Everest II: Reduced plasma ammonia accumulation during progressive exercise to exhaustion. Med. Sci. Sports Exerc. 19:S7, 1987.

PRESENTATIONS:

Charles S. Fulco, M.A.T., What limits $\dot{V}O_2max$ at high altitude? Seminar, Boston University, Boston, MA, November, 1987.

Reed W. Hoyt, Ph.D., Effects of High Altitude on Human Performance. Symposium on the Environment and Human Performance. New England Chapter of the American College of Sports Medicine, Worcester, MA, November, 1987.

ALTITUDE RESEARCH DIVISION

KEY BRIEFINGS:

Richard L. Burse, Sc.D. Recent Technical Studies at Altitude Research Division; DOD Nutrition Board, USARIEM, Natick, MA, May 1987.

Allen Cymerman, Ph.D., Medical Problems at High Altitude and Recent Advances in the Effects of Hypoxia on Nutrition, COL J.F. Stennick, Commanding Officer and Staff of the Marine Corps Mountain Warfare Training Center, Bridgeport, CA, January 1987.

Allen Cymerman, Ph.D., Medical Problems at High Terrestrial Elevations Altitude, U.S. Army School of Aviation Medicine, Ft. Rucker, AL, August 1987.

Allen Cymerman, Ph.D., Medical Problems at High Terrestrial Elevations, U.S. Army School of Aviation Medicine, Ft. Rucker, AL, September 1987.

Allen Cymerman, Ph.D., Defense Intelligence Agency, Survival at High Altitude, Bolling A.F.B., Washington, D.C., October 1987.

Reed W. Hoyt, Ph.D., Medical Testing and Plan to Aid in the Development of the Modular Operational Ration, Dr. A. El Bissi, USARIEM, June 1987.

Reed W. Hoyt, Ph.D., Application of Stable Isotope Techniques to Field Evaluations of Metabolism, Drs. Go, Van Hubbard and Danforth, National Institutes of Health, Bethesda, MD, September 1987.

Reed W. Hoyt, Ph.D., Overview of proposed collaborative high altitude cold weather research project, COL J.F. Stennick, Commanding Officer and Staff of the Marine Corps Mountain Warfare Training Center, Bridgeport, CA, October 1987.

Reed W. Hoyt, Ph.D., Calorie Dense Rations. Sixth meeting of NATO Panel VIII, RSG 8, USARIEM, November 1987.

SIGNIFICANT TDY

Allen Cymerman, Ph.D., Site visit of Sickle Cell Trait Project, William Beaumont Army Medical Center, El Paso, TX, January 1987.

Reed W. Hoyt, Ph.D. Workshop on calorie dense rations, National Research Council, Committee on Military Nutrition Research, Washington, D.C., February 1987.

Reed W. Hoyt, Ph.D., Site inspection for planned field study and finalization of study details with collaborators from the Navy and Marine Corps, Marine Mountain Warfare Training Center, Bridgeport, CA, October 1987.

ALTITUDE RESEARCH DIVISION

SIGNIFICANT VISITORS

Dr. David Leith, Full Professor, Kansas State University, Dept. of Surgery, Small Animal Branch, Manhattan, KS.

Dr. Scott Johnson, Respiratory Division, Brigham and Women's Hospital, Boston, MA.

PROFESSIONAL APPOINTMENTS/ACTIVITIES

CPT Patricia M. Young, CPT, Ph.D., Uniformed Services University of the Health Sciences, adjunct instructor of biochemistry.

CPT Patricia M. Young, CPT, Ph.D., American Physiological Society, full membership.

CPT Patricia M. Young, CPT, Ph.D., American College of Sports Medicine, full membership.

CPT Patricia M. Young, CPT, Ph.D. American Chemical Society, full membership.

Richard L. Burse, Sc.D. Reviewer, Human Factors, Journal of Human Factors Society.

Richard L. Burse, Sc.D. Past President and Director, New England Regional Chapter, Human Factors Society.

Reed W. Hoyt, Ph.D., Sports Medicine Committee member for the annual meeting of the U.S. Rowing Association, September 1987.

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

A minipig model was developed for arterial and venous catheterization using the vascular access port. Development has been started of the same model in microswine.

The ability of bromelain, an enzymatic debriding agent used on burn patients, was tested to debride third-degree frostbite injuries. It was determined that the compound was unsuitable in its present form for this use.

First and third degree frostbite injuries on Hanford Miniature Swine was defined by the clinical signs and healing sequence of the injuries.

Significant progress was made toward a histopathologic definition of experimental frostbite injury.

Hypersensitivity to agonist stimulation is present during hypothermia and does not diminish for up to six hours after rewarming. The mechanism for this sensitivity change may involve some change at the agonist receptor site during hypothermia.

Capacitance vessels (large and small diameter) display initial increased agonist sensitivity, but venous smooth muscle differs from arterial smooth muscle in that the sensitivity reverts to normal within 12 hours.

The Ration, Cold Weather (RCW) is no different from the Ration, Meal-Ready-To-Eat (MRE) in terms of weight loss, calorie intake, or hydration status. Changes are required to increase consumption of the RCW before adoption as the operational ration for extreme cold environments.

Pyridostigmine(PYR), a reversible carbamate inhibitor of acetylcholinesterase (AChE) has been shown to reduce the lethality of organophosphates when used as a pretreatment. However, dose dependent focal lesions have been observed at neuromuscular junctions (NMJ). There are also indications that nifedipine, a calcium antagonist, improves survival in mice treated with antiacetylcholinesterase (antiAChE). If nifedipine decreased susceptibility to an antiAChE, it might also affect the ultrastructural lesions produced by

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

PYR since Ca^{++} flux is involved in both release of acetylcholine and muscle response. Two problems were apparent in preliminary work. The lethality of PYR appeared to be greater than anticipated when large rats were used, and artifacts were observed in tissues processed in solutions previously believed to eliminate similar problems. Large rats were more sensitive to 3.6mg PYR/kg body weight than small rats. Thus, results may be weight-dependent when the dosage is based on mg PYR/kg body weight. Large, control rats had significantly lower serum cholinesterase levels than small rats. This conflicts with work by Shih et al (1987). Modifications in the cholinesterase procedure were necessitated by the use of PYR. Mitochondrial artifacts were reduced or eliminated from control diaphragm muscle when a two-hour fixation with Karnovsky's fixative was used prior to treatment with osmium. However, some contrast and definition were sacrificed. The most consistent focal lesion was the appearance of spherical areas of low electron density within muscle cell mitochondria. A Na^{+} ionophore has been reported to produce similar mitochondrial changes. No changes in myofilaments were observed in this acute study.

Prostacyclin (PGI_2) affects smooth muscle tone, platelet activity, and other cardiovascular functions that affect blood flow during exposure to environmental extremes. Actin polymerization state and arrangement are factors that influence endothelial cell (EC) PGI_2 metabolism. Monomeric actin suppresses, while polymerized actin (F-actin) stimulates phospholipase A_2 (PLA_2) activity, the rate limiting enzyme of the PGI_2 cascade. However, when F-actin is complexed with myosin to form actin stress fibers, PLA_2 activity is also suppressed. A method to quantify stress fiber level is needed in order to study changes in EC stress fiber density in relation to modulations of PGI_2 production. The relationship between stress fiber density and the capacity of rhodamine-phalloidin (R-P) to bind F-actin was explored. Spectrophotofluorometric measurements were used to determine R-P binding capacity after methanol extraction of the R-P-exposed EC cultures. Physical and chemical modulators of EC stress fiber density were studied with this technique. After a 60 min R-P binding period, EC cultures with few stress fibers had a significantly reduced R-P binding capacity, than did cultures with many stress fibers. Thus, an increased R-P binding capacity and an enhanced presence of actin stress fibers appeared to directly correlate. Such a correlation should prove useful in the study of how environmental extremes influence the relationship between EC PGI_2 metabolism and cytoskeletal F-actin arrangement.

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Human plasma fibronectin (PF) level rapidly recovers in survivors of trauma, while it remains suppressed in nonsurvivors. PF replacement therapy is beneficial in the treatment of human patients that have experienced traumatic episodes. Moreover, naturally occurring elevations in plasma PF level correlate with reduced rat heat shock mortality. Thus, procedures that enhance PF level may benefit those exposed to stressful environments. Programs designed to induce thermotolerance or improve physical performance were evaluated for their ability to increase male human PF level. Bothprograms were associated with significant PF elevations. However, in the most stressful program (physical performance enhancement), early phase PF suppression was noted before significant elevations occurred by the end of the program. Since programs for human thermotolerance development induced PF increases, this plasma protein may be an element in the development of thermotolerance. Moreover, because reduced PF level correlates with trauma-related deaths, stressful training programs that temporarily suppress PF level may place subjects at a greater risk to the effects of environmental extremes during this period of suppression. Finally, determination of PF level may have potential as a method for evaluating changes in the relative capacity to endure stressful environments.

Buflomedil (Abbott Laboratories) was evaluated for its ability to ameliorate microcirculatory damage from acute experimentally induced freezing injury in a vascular microcorrosion cast model. This peripheral vasodilator has been reported to decrease tissue loss in human frostbite patients when given intravenously during thawing. In three groups of anesthetized rats, sheathed left hindpaws were cooled to heat of fusion and then recooled to -15°C; right hindpaws were not cooled and served as controls. Prior to cooling, rats in group one received a tail vein injection of saline, while those in group two received a similar injection of buflomedil (1.0mg/100g BW). Rats in group three received a tail vein injection of buflomedil (1.0mg/100g BW) immediately following cooling. Frozen limbs were rapidly rewarmed in a 40°C water bath. Vascular microcorrosion casts were made from the left and right hindpaws of all groups. Mean weights of the casts from the control hindpaws of groups one and three were significantly different from those of their respective frozen hindpaws. The mean weight of casts from control hindpaws of group two was not significantly different from that of frozen hindpaws from the group; this may be due to increased variance in the controls rather than to improved patency in the frozen hindpaws. Mean weights of casts from the three groups of frozen hindpaws were not significantly different, suggesting that, in this model, a single dose of buflomedil administered

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

either prophylactically or therapeutically did not improve vascular patency after frostbite injury.

A report was prepared on death due to carbon monoxide poisoning in two young, healthy climbers at high altitude. Interesting comparisons can be made between carbon monoxide toxicity and hypobaric hypoxia. Physicians dealing with medical problems in a high altitude setting must be aware of the possibility of acute carbon monoxide poisoning mimicking the signs and symptoms of acute mountain sickness.

PUBLICATIONS:

Ahle, N.W., and M.P. Hamlet. Enzymatic Frostbite Eschar Debridement by Bromelain. Ann. Emerg. Med. 16:1063-1065, 1987.

Bowers, W., P. Daum, M. Blaha, C. Stevens, I. Castro and I. Leav. Calcium Antagonists and heat-induced hepatic injury. Virchows Arch B, 53:235-242, 1987.

Daum, P., W. Bowers, Jr., J. Tejada and M. Hamlet. Vascular Casts Demonstrate Microcirculatory Insufficiency in Acute Frostbite. Cryobiology 24:65-73, 1987.

DuBose, D.A., D. Shepro, and H.B. Hechtman. Correlation among Endothelial Cell Shape, F-Actin Arrangement, and Prostacyclin Synthesis. Life Sci. 40:447-453, 1987.

Hamlet, M.P., An Overview of Medically Related Problems in the Cold Environment. Milit. Med., 152:393-396, 1987.

Roberts, D.E., E.W. Askew, M.S. Rose, M.A. Sharp, S. Bruttig, J.C. Buchbinder, and D.B. Engell. Nutritional and Hydration Status of Special Forces Soldiers Consuming the Ration, Cold Weather on the Meal Ready-to-Eat Ration During a Ten Day Cold Weather Field Training Exercise. USARIEM Technical Report T/8, 1987.

Schoning, P. and M.P. Hamlet. Experimental Third Degree Frostbite in Hanford Miniature Swine. USARIEM Technical Report T/24, 1987.

COLD RESEARCH DIVISION

PUBLICATIONS:

Schoning, P. and M.P. Hamlet. Freezing Times, Rewarming Times, and Lowest Temperatures in Experimental Frostbite of Hanford Miniature Swine. USARIEM Technical Report T/27, 1987.

Sharp, M.W., N.W. Ahle, R.A. Mariano, W. Sawyer. Development of a Tissue Freezing and Rewarming Device that uses Compressed Air as a Medium. USARIEM Technical Report T/13, 1987

ABSTRACTS:

Bandick, N.R. and D.E. Roberts. The Effects of Hypothermia and the Reactivity and Contractility of Veins. Physiologist 30:166, 1987.

Daum, P., W. Bowers, Jr., and J. Tejada. Evaluation of the Ability of Buflomedil to Improve Vascular Patency after Cold Injury. Fed. Proc. 46:1440, 1987.

DuBose, D.A., L. Armstrong, W. Kraemer, M. Lukason, and R. Carpenter. Modulation of Human Plasma Fibronectin Levels Following Exercise. Fed. Proc. 46:680, 1987.

DuBose, D.A., D. Shepro, and H.B. Hechtman. Quantitative Method to Determine Relative Differences in F-actin Stress Fiber Formation in Vascular Endothelial Cells. Fed. Proc. 46:1527, 1987.

Jackson, R.L, J. T. Fay, M.W. Sharp, L.J. Falco and E. Kraus. Cardiovascular and Temperature Responses of Blacks and Whites to Hand Cooling. The Physiologist 30:167, 1987.

Roberts, D.E. and N.R. Bandick. Arterial Contractility Following Hypothermia. The Physiologist 30:166, 1987.

Spero,, B., M.L. Wynn, N.R. Bandick, and D.E. Roberts. Viscoelastic and Contractile Properties of Arterial Walls During Aging and Spontaneous Hypertension. The Physiologist 30:186, 1987.

COLD RESEARCH DIVISION

PRESENTATIONS:

Ahle, N.W. Enzymatic Frostbite Eschar Debridement by Bromelain. University Association of Emergency Medicine, Clearwater, Florida, February 1987.

Hackett, P.H., R.C. Roach, R.T. Meehan, I.D.B. Rennie, R. Foutch, R. Wood, W.J. Mills. Dexamethasone for Prevention and Treatment of Acute Mountain Sickness. The Fifth International Hypoxia Symposium, Lake Louise, Alberta, Canada, February 1987.

Foutch, R.G., and W.J. Mills. Treatment and Prevention of Cold Injuries by Ancient Peoples Indigenous to Arctic and Subarctic Regions. 7th International Congress on Circumpolar Health, Umea, Sweden, June 1987.

KEY BRIEFINGS:

Neil W. Ahle, CPT. Cold Weather Injury Prevention, New Hampshire Army National Guard Annual Training, Bourne, MA, June 1987.

Neil W. Ahle, CPT. Cold Weather Injury Prevention, North Carolina Army National Guard Annual Aviation Safety Conference, Charlotte, NC, December 1987.

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, Drs. Chen & Sun, Peoples Republic of China, USARIEM, Natick, MA, February 1987.

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, COl Perry, HQ, MRDC, USARIEM, Natick, MA, March 1987.

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, MG Drummond, CG, Operational Test and Evaluation Agency, USARIEM, Natick, MA, March 1987.

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, Dr. Bowen, Neurosurgeon, USARIEM, Natick, MA, April 1987.

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, MG Russell, CG, MRDC, USARIEM, Natick, MA, May 1987.

COLD RESEARCH DIVISION

KEY BRIEFINGS:

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, NATO Panel VIII (Nutritional Aspects of Military Feeding), USARIEM, Natick, MA, November 1987.

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, SGM Small, USA MEDDAC, USARIEM, Natick, MA, November 1987.

Neil W. Ahle, CPT, and Mark W. Sharp, SSG. Provided Infrared Thermography Briefing, Surgeon Commander Howard Oakley, Head of Survival & Thermal Medical Institute of Naval Medicine Royal Navy, USARIEM, Natick, MA, March 1987.

Murray P. Hamlet, D.V.M. Cold Weather Briefings to Army Flight Surgeon Course, Dothan, Alabama, March 1987.

Murray P. Hamlet, D.V.M. Cold Injury Prevention Briefing to Army Flight Surgeon Primary Course, Fort Rucker, Alabama, July 1987.
Murray P. Hamlet, D.V.M. Operation Deep Freeze Pre-Deployment Briefing, Pt. Mugu, Los Angeles, August 1987.

Murray P. Hamlet, D.V.M. Hypothermia briefings to medical staff and Ranger Department, Ft. Benning, Georgia, September 1987.

Murray P. Hamlet, D.V.M. Briefing to Naval Reserve Readiness Command Region on Trauma Management of Cold Weather Injuries, Rickenbacker Air National Guard Base, Columbus, OH, September 1987.

Murray P. Hamlet, D.V.M. Briefing to Officers on Prevention and Management of Cold Injuries, Ft. Dix, Newark, NJ, October 1987.

Murray P. Hamlet, D.V.M. Consulted and Briefed medical staff on cold injuries at Fort Benning, Georgia, December 1987.

Richard Foutch, MAJ. Mountain Sickness, the USAF School of Aerospace Medicine Global Medicine Course at Brooks AFB, San Antonio, Texas, February 1987.

Richard Foutch, MAJ. Accidental Hypothermia, lecture to 176th Medical Group, Special Cold Weather Medical Course at Northern Warfare Training Center, Ft. Greely, AK, February 1987.

COLD RESEARCH DIVISION

KEY BRIEFINGS:

Richard Foutch, MAJ. Instructor in Advance Cardiac Life Support Courses at Bassett Army Community Hospital, Ft. Wainwright, AK, 1987.

Richard Foutch, MAJ. USARIEM Field Hydration Study of the Ration, Cold Weather, briefed command staff at 6th ID(L) HQ regarding support for this test, Ft. Richardson, AK, September 1987.

Richard Foutch, MAJ. Cold Weather Indoctrination, 5-9th Infantry, Ft. Wainwright, AK, December 1987.

SIGNIFICANT TDY:

Andre A. Darrigrand, MAJ. To attend Continuing Education Conference, American Association of Laboratory Animal Science, November 1987.

Andre A. Darrigrand, MAJ. To visit Elliott Field Research Station, University of California-San Diego and Letterman Army Institute of Research to observe vascular catheterization techniques in swine, March 1987.

Murray P. Hamlet, D.V.M. To consult on cold injuries and cold weather studies at Mountain Warfare Training Center, Pickle Meadows, Bridgeport, CA, January 1987.

Murray P. Hamlet, D.V.M. To attend joint work group on water purification, storage, and distribution in cold weather environments, Ft. Lee, Virginia, May 1987.

Murray P. Hamlet, D.V.M. To conduct briefing at Norwegian Army Conference on Cold Weather Operations held in Norwegian Military Academy, Oslo, Norway, June 1987.

Murray P. Hamlet, D.V.M. To coordinate Infrared Thermography blood flow studies on Argentine trenchfoot casualties, Buenos Aires, Argentina, October 1987.

Donald E. Roberts, Ph.D. and David L. Moore, SSG. To Ft. Campbell, KY, to complete the post testing on the use of classical conditioning to relieve cold intolerance following cold injury, January 1987.

Donald E. Roberts, Ph.D. To Umea, Sweden to participate in the 7th International Congress on Circumpolar Health, June 1987.

COLD RESEARCH DIVISION

SIGNIFICANT TDY:

Richard Foutch, MAJ. To Ft. Greely, Kodiak and Galena, Alaska, to observe medical operations and casualty play during Brimfrost '87 exercise, January 1987.

Richard Foutch, MAJ. To Lake Louise, Alberta, Canada for the Fifth International Hypoxia Symposium, February 1987.

Richard Foutch, MAJ. To USARIEM for duty as medical monitor of heat study and to plan for future projects, Natick, MA, July 1987.

Richard Foutch, MAJ. To Ft. Richardson, Alaska, to lecture to the medical support team, to meet with COL David Lam to brief the 6th ID(L) G-3 on the RCW study on October 1987.

SIGNIFICANT VISITORS:

Dr. Chen and Dr. Sun, Peoples Republic of China, 17 February 1987.
Surgeon Commander Howard Oakley, Head of Survival and Thermal Medicine, Institute of Naval Medicine, Royal Navy, Alverstoke, England, 3-4 March 87.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Patricia S. Daum, Guest Referee, Crybiology.

Saleh M. Rahman, Mathematics and Statistics Teacher, Lexington High School, Lexington, MA, served as 1987 Batelle Award recipient to act as statistical advisor for the Cold Research Division, 1987.

EXERCISE PHYSIOLOGY DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

In a study to assess the physiological determinants of maximal power during leg cycling exercise, muscle fiber type and mass were found to be poor predictors in non-elite subjects. This suggests that in such individuals a combination of physiologic factors and performance strategies may be employed in the production of maximal power.

Manual materials handling capacity can be increased in inexperienced lifters with short exercise periods in which the soldier controls the exercise intensity. The amount of work accomplished in a given time period was increased following four weeks of psychophysical training without significant increases in oxygen uptake, heart rate or ratings of perceived physical exertion.

Data gathered at the Boston Marathon suggests that medical casualties among participants can be predicted reasonably well using a linear model ($Y=3.097 + .698X$). Risk of becoming a casualty appears to increase about 10% for every 10°C starting at 5°C a point at which the risks are about 7%. Also, Boston Marathon data demonstrates that the crude risks of becoming a medical or musculoskeletal casualty are greater for women than men, but are the same when the risk is age adjusted. Also, it appears that older marathoners are less likely to become medical casualties of the race, but are more likely to drop out. This suggests that older runners may modify their risks by prudent judgment.

Volume of running mileage appeared to be the primary risk factor for injury in the two training companies observed over the 13 one-station-unit-training week cycle at Ft. Benning. The company (n=169) doing the most running (130 miles) had the highest risk of injury compared to the company (n=156) running the least (60 miles). The overall risks for injuries were 54% versus 41%, respectively for the high versus low mileage companies. Interestingly the low mileage group had run times that were just as fast on the final PT test as the high mileage company. It appeared that for each mile run a quantifiable risk could be attached which was the same for both companies. As with our previous findings at Ft. Jackson, low levels of fitness, as measured by two mile run times and diagnostic PF test scores, were associated with increased likelihood of injury as was sedentary life style prior to entering the Army. Another important finding of this study was that those who were the most flexible had an increased risk (31%) of injury when compared to those of average (risk=19%) flexibility as did those who were the least flexible (risk=39%). Also, individuals who were over the age of 23 were at significantly increased risk

EXERCISE PHYSIOLOGY DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

of injury as was found at Ft. Jackson. Of further interest was that the risk of injury for Army trainees are similar to those for high school athletes.

In a study contrasting the effects of different modes of physical training on power development, it was found that: a) strength training produced increases in power output which may be related to increases in fat free mass, b) high intensity endurance training alone does not alter power output, c) increases in power output appear to be specific to the strength trained musculature, d) high intensity endurance training appears necessary to make changes in percent body fat while strength training is necessary to alter fat free mass and e) simultaneous strength and high intensity endurance training may impede increases in power output.

The use of a belt increases intra-abdominal pressure during weight lifting and changes the timing of pressure generation. Results suggest use of a belt can improve lifting safety.

There are a number of differences in the mechanics of maximal power pedalling at two different speeds, indicating neuromuscular speed specificity in patterns of maximal force exertion.

Intra-abdominal pressure increases with amount of weight lifted. However, the magnitude of the response is dependent upon the type of lift. A starting position for a lift with knees close to chest facilitates intra-abdominal pressure generation. Reaching forward with the arms tends to suppress intra-thoracic pressure generation.

A training program consisting of running alone can significantly reduce maximal leg power, particularly at higher speeds. However, weight training increases leg power even when run training is performed as well.

PUBLICATIONS:

Dziados, J. E., A. I. Damokosh, K. L. Farmer, Jr., R. P. Mello and J. A. Vogel. Physiological determinants of load bearing capacity. USARIEM Technical Report T/19, June 1987.

EXERCISE PHYSIOLOGY DIVISION

PUBLICATIONS:

Fleck, S. J. and W. J. Kraemer. Designing Resistance Training Programs. Human Kinetics, Champaign, IL, 1987.

Harman, E. Using IMSL mathematical and statistical computer subroutines in physiological and biomechanical research. USARIEM Technical Report T/5, 1987.

Harman, E., P. Frykman, H. G. Knuttgen, J. Patton. Exercise endurance time as a function of percent maximal power production. Med. Sci. Sports Exerc., 19:480-485, 1987.

Harman, E., H. G. Knuttgen, P. Frykman. Automated data collection and processing for a cycle ergometer. J. Appl. Physiol., 62:831-836, 1987.

Harman, E. Biomechanics and exercise selection. In Resistance Training: Exercise Prescription and Program Design by S. Fleck and W. Kraemer, Human Kinetics, Champaign, IL, 1987.

Hodgdon, J. A. and P. I. Fitzgerald. Validity of impedance predictions at various levels of fatness. Hum. Biol. 59:281-298, 1987.

Knapik, J. J., B. H. Jones, C. Meredith, W. J. Evans. Influence of 3.5 day fast on physical performance. Eur. J. Appl. Physiol. 56:428-432, 1987.

Kraemer, W. J., L. E. Armstrong, L. J. Marchitelli, R. J. Hubbard, N. Leva. Plasma opioid peptide responses during heat acclimation in humans. Peptides. 8:715-719, 1987.

Kraemer, W., J. A. Vogel, J. F. Patton, J. E. Dziados, K. L. Reynolds. The effects of various physical training programs on short duration, high intensity load bearing performance and the Army physical fitness test. USARIEM Technical Report No. T/30, 1987.

Knuttgen, H. G. and W. J. Kraemer. Terminology and measurement in exercise performance. J. Appl. Sports Sci. Rsch. 1:1-10, 1987.

Legg, S.J. and J.F. Patton. Effects of sustained manual work and partial sleep deprivation on muscular strength and endurance. Eur. J. Appl. Physiol. 56:64-68, 1987.

EXERCISE PHYSIOLOGY DIVISION

PUBLICATIONS:

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EXERCISE PHYSIOLOGY DIVISION

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KEY BRIEFINGS:

Bruce H. Jones, MAJ, M.D., M.P.H. Risk factors for injury in military trainees, to MG Hoar, Commander Marine Corps Recruit Depot, Recruit Depot HQ Staff, and Hospital staff, Parris Island, SC, July 1987.

Bruce H. Jones, MAJ, M.D., M.P.H. Epidemiology of training-related injuries in Army Infantry trainees; preliminary results of the Ft. Benning study, to COL E. Takafuji, Walter Reed Army Institute of Research, Wash, DC, July 1987.

Bruce H. Jones, MAJ, M.D., M.P.H. Infantry Training Injury Study debriefing, to COL Siegfried (now BG Siegfried), Commander Army Infantry Training Center, Ft. Benning, GA, May 1987.

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EXERCISE PHYSIOLOGY DIVISION

KEY BRIEFINGS:

Bruce H. Jones, MAJ, M.D., M.P.H. Infantry Training Injury Study debriefing, to COL Mace, Commander, 1st Infantry Training Brigade, and HQ staff, Ft. Benning, GA, May 1987; same briefing to Acting Commander, 2nd Infantry Training Brigade.

Katy L. Reynolds, MAJ, M.D. The Epidemiology of Load Bearing related injuries among the military. 9th Regiment, 7th Infantry, Ft. Ord, CA, September 1987.

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James A. Vogel, Ph.D. Physical performance research program. U.S. Army War College, Carlisle Barracks, PA, March 1987.

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SIGNIFICANT TDY:

MAJ Katy Reynolds, Load carriage injury field study - Manchu 100, Ft. Ord, CA, Sep 1987.

MAJ Bruce Jones, Infantry OSUT injury study, Feb-May 1987.

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HEALTH AND PERFORMANCE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Acutely stressful situations can disrupt behavior and deplete brain neurotransmitters. In animals, administration of tyrosine, a large neutral amino acid and dietary precursor of the catecholamines, reduces these behavioral and neurochemical deficits. We investigated whether tyrosine (100 mg/kg) would protect humans from some of the adverse consequences of a 4.5 hour exposure to environmental stressors. Tyrosine significantly decreased symptoms, adverse moods, and performance impairments in subjects who exhibited average or greater responses during cold and high altitude exposure. This suggests that treatment with tyrosine may benefit humans during acute exposure to cold and high altitude stress, perhaps by affecting central catecholamines.

In a research study the moods of friendliness, clear thinking, dizziness, sleepiness, and unhappiness, were adversely affected at 4300 m. Only sleepiness increased at 1600 m. At 4300 m, the altered moods differed from baseline after 1-4 hours, differed even more after 18-28 hours, and returned to baseline by 42-52 hours. Morning and evening values for various moods were similar at each altitude. Therefore, measures of mood states (Clyde Mood Scale) at altitude have a distinct and measurable time course.

A symposium was conducted to evaluate current research that suggests that it may be possible to monitor the state of the soldier in operational settings and predict his near-term performance capabilities. Critical issues requiring consideration and resolution for applications in operational environments were identified and discussed. Ongoing data from research methodologies were presented by subject-matter experts (workload assessment, evoked potentials, electroencephalography, and heart rate variability).

Cognitive function at simulated altitude was investigated in seven subjects in a repeated measures within-subject study of performance in a hypobaric chamber. Atmospheric pressure was systematically reduced over 40 days, to a pressure equivalent to the height of Mount Everest. The cognitive test battery (Automated Performance Test System) used was designed for field research under adverse environmental conditions as evidenced by compact computer design; automated test administrations, data storage, and retrieval; and psychometric properties of stability, reliability, and factorial richness. Significant impairments of cognitive function were seen for three of the five tests in the battery, and on two tests, grammatical reasoning and pattern comparison, every subject showed a substantial decrement. These data show the impact of altitude on specific

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aspects of cognitive function and the importance of having sensitive and reliable instruments to monitor such effects.

We examined the performance of female soldiers in chemical protective clothing while they were engaged in sustained performance of a cognitive nature, in the heat. Eighteen female soldiers trained for two weeks on cognitive tasks resembling those performed by fire direction center, forward observer and communications personnel. Then they performed the tasks for seven-hour periods on four successive days in hot (91°F, 61% RH) and normal (55°F, 35% RH or 70°F., 35% RH) conditions, with and without chemical protective clothing. The data indicated that after three hours in the hot environment, while clad in MOPP IV, the women, as a group, showed a marked decrease in the ability to sustain performance. Of the 17 soldiers tested, two had to be evacuated from the heat in the third hour of exposure, three in the fourth and five in the fifth. The remaining seven showed no adverse effects of heat and MOPP IV on the performance of any task. No differences were found between heat casualties and non-casualties in core temperatures or in water consumed during the heat exposure. Reasons for evacuation included fainting, about to faint, incoherent responses to questions, feelings of total exhaustion or an expressed statement by the participant that she wished to terminate. In terms of unit performance, the necessary evacuation of more than 50% of the "unit" represented by the women in this study, prior to six hours of heat exposure, has serious implications. Additional research is needed to determine whether gender differences observed between this and a previous study with male soldiers reflect basic physical, physiological or psychological differences between sexes or reside in transient factors peculiar to the specific samples involved, such as differences in physical fitness, size, attitude, experience, or state of heat acclimation. The performance of a majority of participants also was adversely affected by wearing MOPP IV at 55°F., despite having had eight hours of practice on the tasks in the gear at that temperature. This result is similar to, but more severe than, that found with male soldiers. Reasons for the adverse affect are unclear, but do not seem to be due to interference of gloves and/or mask with dexterity or vision. The stress of adapting to the novel experimental situation for the first time is posited as a possible explanation. Training personnel to do their jobs in MOPP IV under the most realistic conditions possible is recommended.

We examined the separate and combined effects of cigarette smoking and field-dependence on contrast sensitivity. No previous research on these relationships exists. Each of the three variables is known to be related to

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SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

many aspects of military performance. Twelve smokers and 16 non-smokers were tested for field-dependence and measured for contrast sensitivity under carefully controlled conditions. No differences were found in contrast sensitivity of the smoker group when measured immediately after smoking one cigarette as compared with having been deprived of smoking for at least 90 minutes. Habitual smoking and field-dependence were found to be separately and interactively related to contrast sensitivity. A field-independent non-smoker group performed significantly better than a field-dependent smoker group at all but the lowest spatial frequency. The results have important implications for a variety of military tasks, particularly aircraft and motor vehicle operations and target detection and may be useful as selection criteria.

During exposure to a hot environment, unacclimatized soldiers may not voluntarily drink enough water to compensate for the loss of fluids. A study was conducted to evaluate whether, with increased voluntary drinking (due to cooling and/or flavoring the drinking water), the soldier (a) will be less likely to report feelings of discomfort and symptoms of heat illness and (b) will also be better able to maintain his ability to perform psychomotor and cognitive tasks. On each of four test days in a heat chamber (40° C dry bulb/29.8° C wet bulb), eight exercising male subjects were permitted to drink ad-lib only one of four beverages: cool water, warm water, cool flavored water, or warm flavored water. Subjects consumed significantly less water under the warm water conditions than under the cool water conditions, and the subjects felt more uncomfortable and reported more symptoms of heat illness under the warm water conditions. Subjects lost more body weight during the course of those test days when they were allowed to drink only warm water than those days when they were allowed to drink cool water. There was no difference in water consumption between water flavoring conditions. Psychomotor performance (manual dexterity, as measured by the Purdue Pegboard Assembly Test and the O'Connor Fine Finger Dexterity Test) and cognitive performance (logical reasoning, as measured by the Baddeley Reasoning Test) were significantly degraded under the warm water conditions but only after at least four hours of heat exposure. Flavoring the water had no effect on any of the measures. It is concluded that under hot weather conditions, degradation in psychological performance may be attenuated if soldiers are provided cool as opposed to warm drinking water, and that this change in performance is related to the improved hydration status of the subject.

The logistical significance of chemical weapons in future warfare demands that nerve agent antidotes be available for troops exposed to chemical

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SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

attack. Since future combat operations will most likely occur in tropical and desert areas, chemical attacks in such areas could lead to situations involving the use of nerve agent antidotes by troops during exposure to hot and hot-humid conditions. Virtually no data are available to estimate performance capabilities on psychologically based tasks under this combination of circumstances. A study was conducted to assess, both independently and in combination, the effects of heat exposure (95°F, 60% RH) and US Army standard dosages of nerve agent antidotes (2 mg atropine and 600 mg 2-PAM chloride) on the performance of a variety of tasks selected for their relevance to military operations from the USARIEM Performance Inventory (UPI). The UPI tasks selected for inclusion assessed sensory functioning, perceptual-cognitive functioning, sensorimotor skill, subjective reactions, and direct military skills such as M16 rifle marksmanship. Fifteen soldier volunteers were first trained to asymptotic performance on the UPI task battery. Then, over a period of four test days, they completed a counterbalanced schedule of the drug/no drug and heat/no heat conditions while outfitted in the battle dress uniform. On each test day, the tests from the UPI were administered once during each of the three, 2-hour test cycles. Compared to the placebo condition, a single dose of nerve agent antidote significantly impaired soldier performance such that visual reaction time was 10% slower, gross body mobility was 12% poorer, and rifle marksmanship was 3% less accurate. When soldiers received nerve agent antidote and ambient heat together, ambient heat did not interact with the nerve agent antidote to further impair soldier performance.

A study was conducted to examine the psychological mood states of students enrolled in an intensive mountaineering training program. Thirty-two male armed forces personnel were observed while participating in an eight day program combining classroom training (CT), field instruction (FI), and a field training exxercise (FTX). The Profile of Mood States (POMS) questionnaire was administered to the students twice daily, at the morning and evening meals. At each administration, the students evaluated their feelings with respect to the previous 12 hours. The POMS assesses six mood states: tension, depression, anger, vigor, fatigue, and confusion. A 2 x 8 (time of day x day) repeated measures analysis of variance was conducted on each of the six scales of the POMS. A significant main effect of time of day was found on each scale. Feelings of tension, depression, anger, fatigue, and confusion were significantly higher ($p<.001$) at the evening administration. A significant main effect was also found across days on all six scales ($p<.05$). Here, levels of tension, depression, anger, fatigue, and confusion increased as each new element (CT, FI, FTX) of training was introduced; the level of vigor declined with each new phase of training. The

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SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

increased activity experienced during the daytime resulted in more intense negative moods and a suppressed feeling of vigor. The type of activity experienced affected the moods reported. The longer the training continued, the more pronounced these trends became.

The possible deployment of nerve agents necessitates both effective antidotes and protective clothing for military personnel. The current Army nerve agent antidotes (atropine sulfate and 2-pam chloride) can generate debilitating behavioral side-effects, and heat exposure combined with these drug effects could further impair troop performance capability. Furthermore, heat effects will increase when troops wear the Mission Oriented Protective Posture (MOPP) system, particularly at the MOPP-IV level. A study was conducted to assess the combined effects of heat exposure (95°F, 60% RH), wearing of the MOPP-IV ensemble, and atropine (2 mg)/2-pam (600 mg) dosage on the performance of a variety of psychological tasks selected for their relevance to military operations. Eight male soldier volunteers, ages 18-22, were first intensively trained on the selected performance tasks, including visual, auditory, cognitive and psychomotor skills, rifle marksmanship, and personal judgements of symptomatic reactions and feeling states. Following training, they performed the tasks on four separate days involving exposures to all combinations of drug or placebo and heat or comfortable ambient conditions. Subjects were targeted to complete three successive total performances of all tasks (cycles) on each day. Based on analysis of variance of the data, drug main effects occurred for rifle marksmanship, reaction time, body mobility, and verbal reasoning. All levels of marksmanship were affected (10% lower accuracy for pop-up targets; 1 x 1 shot group 11% less accurate; 2 x 2 shot group 12% less accurate). Compared to a similar study in which subjects wore the battle dress uniform (BDU) rather than MOPP-IV, reaction times were significantly slower (27% slower for simple, and 50% slower for choice). Body mobility was about equally affected under BDU and MOPP-IV, but verbal reasoning was slower under MOPP-IV (14% fewer completions) than under BDU (6% fewer completions). There was also a drug main effect for digit-symbol substitution under MOPP-IV, but not under BDU. Significant main effects for temperature were obtained on all of the objective measures under MOPP-IV, due undoubtedly to the greatly increased heat load generated by wearing the impermeable MOPP-IV system. The heat stress was so severe that only one subject completed some of Cycle 2, and no one began Cycle 3. High symptomatic ratings were obtained for reactions due primarily to heat exposure, some drug effects related to visual effects of atropine, and general alterations of well-being.

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SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Mood profiles as well as changes in moods as a result of running an ultramarathon were examined in ultramarathon runners. Ultramarathoners exhibited the iceberg profile on the POMS as has been found in other athletic groups. Changes in mood states upon running the ultramarathon were characterized by increased levels of depression, fatigue and confusion as well as decreased levels of tension and vigor post race. Results from examination of strategies used in running an ultramarathon reveal that strategies which aid in breaking up the race into segments, are associated with a more successful performance. Finish time was predicted with the use of a multiple regression equation using two factors, subject's estimated time and training pace. Mood changes as a result of six different resistance exercise protocols were also examined. It was found that subjective negative moods were associated with protocols which had shorter rest periods, greater repetitions/lower weight and more total work being done. Additionally these feelings persisted for a longer period of time (up to 24 hours post workout) than in protocols which had longer rest periods, lower repetitions/greater weight, and less total work.

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HEALTH AND PERFORMANCE DIVISION

PUBLICATIONS:

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PRESENTATIONS:

McMenemy, D.J. and R.F. Johnson. Psychological moods of soldiers during training in mountainous terrain. New England Chapter of the American College of Sports Medicine, November, 1987.

Tharion, W.J. and T.M. Rauch. Psychological and training factors associated with ultramarathon performance. New England Chapter of American College of Sports Medicine, Worcester, MA, November 1987.

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KEY BRIEFINGS:

Johnson, R.F. Chemical protection and environmental stress: effects on hearing and manual dexterity. Lecture presented at the course Current Concepts in Environmental Medicine, US Army Research Institute of Environmental Medicine, Natick, MA: May 1987.

Kobrick, J.L. Environmental stress, hypoxia and performance. Lecture presented as part of Current Concepts in Environmental Medicine, US Army Research Institute of Environmental Medicine, Natick, MA, May 1987.

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HEALTH AND PERFORMANCE DIVISION

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John L. Kobrick, Ph.D. Editorial Consultant, Aviation, Space and Environmental Medicine.

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HEAT RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

De-emphasis of the role of anhidrosis as a primary cause of heatstroke has resulted in increased usage and acceptance of animal models for heatstroke research. There is an apparent paradox between the dogma that heat is the sole noxious agent precipitating heatstroke and the observation of a significantly higher moribidity and mortality with exercise-hyperthermia than equivalent hyperthermia alone. When the total amount of work achieved by the running rat prior to exhaustion was plotted against the rate of heat storage, a heretofore unrecognized relationship emerged. These new data suggest that physical exhaustion and heat exhaustion represent opposite ends of a continuum related to the rate of heat storage. Changes in thermoregulatory and/or physical performance can be estimated by a two-dimensional shift in the work-output/thermal storage ratio. Although this research was developed primarily within the task area "Research on military disease, injuries and health hazards: Environmental physiology", significant progress and insight was achieved when combined with progress achieved in the task area "Medical defense against chemical agents: Work limitations induced by antidotes". For example, physostigmine, which produces an exaggeration of the normal response to acetylcholine produced a significant increase in heating rate of rats coupled with a significant reduction in endurance capacity. The administration of the anticholinergic atropine, the anticonvulsant diazepam as well as physostigmine prior to running, returned performance to normal levels. The administration of atropine plus diazepam improved it. These observations, in combination with other results and theory have produced a new hypothesis which suggests that a series of factors operate in exercise-induced hypthermia to increase the permeability of the cell membrane, primarily to sodium ions. There is increasing evidence that permeability to other ions including magnesium and phosphorous increase in parallel to hyperthermia and respiratory alkalosis. Evidence suggests that this phenomenon is playing a role in a non-classical form of exertion-induced heat exhaustion characterized by hyperventilation, respiratory alkalosis, syncope and muscle cramps. The continued leakage of sodium ions will stimulate the sodium-potassium ATPase (the Sodium Pump) and an inefficient energy drain upon the cell (The Energy Depletion Model) results. The concept takes the form of a viscious circle (Annals of Emergency Medicine 16:1066-1075, 1987) leading to increased heat production and storage, reduced exercise-heat tolerance and significant morbidity and mortality. This model predicts that cellular/metabolic processes and deficits operate for some time after hyperthermia has subsided with cooling.

HEAT RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

Atropine is widely used both as a preanesthetic and an antidote for organophosphate poisoning. In our rat model of human heat injury we have administered atropine intravenously (iv); in man administration is by either the intravmuscular (im) or iv route. Therefore, we determined and compared the dose-response effects of im and iv administration in rats. Adult male rats (500g) were heat-stressed (41.5°C) while unrestrained and therefore able to thermoregulate by saliva spreading activity. We quantitated the effects of im or iv atropine (10-4000 ug/kg) on the following variables: heating rate (HR), % wt loss (saliva production), and fecal loss (intestinal motility). Further, we examined the effects of atropine on pupil dilation in restrained rats at 26°C. HR, the most sensitive index of drug activity, was identical for both routes of atropine administration at 200 ug/kg (equivalent to the standard 2 mg dosage in man) but the range of doses over which there was a dose-response effect on HR with iv administration (10-1000 ug/kg) was markedly truncated with the im route (10-50 ug/kg). Both im and iv atropine had similar effects on wt loss rate; however, im atropine inhibited intestinal motility more than iv atropine. Both routes of administration elicited a dose-response effect on pupil dilation from 25 to 1000 ug/kg; however, the dilation lasted one hour longer at each im dosage. For the purposes of our model the iv route is preferred because the most sensitive physiological response (HR) is affected over a wider dose range.

We have reported that when rats (500 g, male) are exercised to exhaustion on a treadmill, pretreatment with the centrally acting carbamate physostigmine reduced endurance (run time, RT) and increased the rate of rise of core temperature (Tc+). Both RT and Tc+ were restored to control levels by pretreatment with either/or a combination of atropine (A), and diazepam (D). Our objective in the present work was to determine whether A+D could also restore the performance and thermoregulatory decrements induced by the peripherally acting carbamate pyridostigmine (PY). After drug administration, rats were run (11m/min, 6° elevation, Ta=26°C) to exhaustion. PY treatment resulted in a reduced RT and an increased heat gain that neither A nor D alone (A+PY and D+PY) could restore to control levels. On the other hand, a combination of both A and D restored these variables to control levels. In conclusion, A+D can restore the performance and thermoreglatory decrements resulting from the administration of either a centrally or a peripherally acting carbamate.

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SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

As part of a large-scale field feeding system test we were able to collect and study hundreds of aliquots of overnight urine samples obtained immediately prior to a fasting blood sample on days 1, 20, and 44 of the field test. Urine aliquots for all test days were initially categorized by specific gravity (SG) $\geq$1.03 (n = 124) or $\leq$ 1.03, n = 540). Creatinine levels were elevated ($P < 0.001$) in the concentrated urine samples, but a decreased trend in sodium-to-potassium ratios in these samples failed to achieve statistical significance ($P > 0.05$). However when individuals with high SG urine were subclassified by a criterion of weight loss >3% from original body weight, then creatinine concentrations were elevated ($P = 0.05$), whereas sodium-to-potassium ratios were decreased ($P = 0.05$) when subjects also with high SG but weight loss <3% were compared. Because of the moderate altitude (2,000 m) of the field site and the time of sojourn (44 days), there occurred a slight, but significant ($P < 0.001$), erythropoietic response. However, serum urea nitrogen-to-creatinine ratios were increased (days 1 and 44, $P < 0.05$) in test subjects whose urine samples exceeded 1.03 in SG. The results of this study indicated that mild hypohydration, manifested in concomitant elevations in urinary SG and creatinine, was not reflected in the common circulatory indices of hypohydration, i.e., hematocrit and osmolality. Alternatively, urea nitrogen-to-creatinine ratio may be a sensitive circulatory index of imminent hypohydration.

Adult (300g), male rats (n=64/group) had access to either tap water or tap water containing 300 mg/L or pyridostigine bromide (PYR) for 1 week prior to experimentation; this was followed by exercise (9.14m/min, level treadmill) at 30°C to hyperthermic (Tre=42°C) exhaustion. Thirty min prior to the exercise, pyridostigmine (PYR) - and water-drinking groups were treated with an additional intraperitoneally administered regimen: saline (1ml, SAL), atropine sulfate (200ug/kg, ATR), pyridine-2-aldoxime methiodide (50mg/kg, 2PAM), or atropine plus pyridine-2-aldoxime methiodide (ATR+2-PAM), thus forming eight experimental groups. Mean endurance ranged from 50.4 min (PYR-ATR-2-PAM) to 76.3 min (PYR). The four groups receiving 2-PAM manifested a mean endurance of 53.9 min while the four groups not receiving 2-PAM had a mean endurance of 66.2 min. Blood samples were taken immediately prior and subsequent to exercise in the heat. Hematocrit, total protein, and osmolality were unaffected by PYR and other regimens while osmolality, lactic acid dehydrogenase, creatinine, urea

HEAT RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

nitrogen, and lactate were elevated by the heat/exercise. While creatine phosphokinase was minimally elevated by the mild exercise, these elevations were exacerbated in the 2-PAM groups. Pyridostigmine consumption for one week reduced circulating cholinesterase activity by 25%. While treatment with 2-PAM restored part of this activity, there were indications (endurance capacity and CPK efflux) that 2-PAM may have subsequent adverse effects on the ability to work in the heat. While indices of heat/exercise injury were oridinarily increased by exercise in the heat, elevations were generally unaffected by pharmacological intervention.

Simple tests which can accurately predict heat tolerance have great potential in industrial, military and clinical settings. Such tests were first designed in the 1930's for use with prospective mine laborers in South Africa (Dreosti 1935; Wyndham 1953) to identify heat intolerant workers; however, these elevations required heated, climatically controlled facilities which precluded their widespread usage. More recently, the Israeli research team of Shvartz et al. (1977) set out to detrmine if heat intolerance could be predicted by a simple exercise test performed at room temperature. They reported that a temperate environment heat tolerance test (HTT) was able to distinguish former heat stroke patients from normal individuals, and to distinguish heat acclimatized from unacclimatized indiividuals. Because it was not clear whether HTT was sensitive enough to track acute changes in physiological responses, we planned to induce measurable HR and Tre adaptations in our test subjects by using heat acclimation as the stimulus. Therefore, the purpose of this investigation was to evaluate the ability of HTT to measure acute changes in HR and Tre induced by heat acclimation procedures, thereby revealing its validity and sensitivity as a heat tolerance screening device. Evaluation of an Israeli temperate environment test to predict human heat tolerance indicated that this test was not a substitute for classical heat tolerance tests conducted at high ambient temperatures. HTT is apparently most useful in patient or at-risk populations in which preliminary or gross distinctions between heat tolerant and heat intolerant individuals are required.

The purpose of this investigation was to evaluate the effectiveness of a new, self-contained cooling headpiece (CHP) in reducing environmental heat stress. The CHP was designed to be worn by the soldier working under thermally

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stressful conditions, and requires no auxiliary sources of cool air or water. Two male subjects underwent 30 minutes of strenuous cycling on a bicycle ergometer in a climatic chamber at 104°F (40°C). Three trials were conducted on consecutive days: no CHP was worn on day 1, a warm CHP was worn on day 2, and a cold CHP was worn on day 3. The CHP was applied immediately before exercise and was worn for the entire 30 minute period. The cold CHP significantly reduced rate of esophageal temperature rise (Tes), heart rate (HR), heat strain index (SI) and heat storage (HS) in both subjects. No differences were observed in sweat rate (SR) or mean weighted skin temperature (MWST). The CHP minimizes the physiological strain of working in a hot environment by removing a significant amount of heat from the scalp and face. Although the device has several advantages - it is untethered, re-useable and inexpensive to manufacture - limitations were noted. We conclude that the CHP has the potential to reduce the risk of hyperthermia in several military situations of short duration, and shows promise for further research and development.

Clinical descriptions of heat exhaustion often include various combinations of headache, dizziness, fatigue, hyperirritability, anxiety, tachycardia, hyperventilation, diarrhea, nausea, vomiting, syncope, heat cramps, "heat sensations", piloerection, and chills. This has led (Callaham, 1979) to describe heat exhaustion as a vague syndrome that is best diagnosed by excluding the other heat illnesses. Although it is believed that heat acclimatization and physical training decrease the risk of heat illness, heat exhaustion may be observed in thoroughly acclimatized or well-trained individuals when exercise is performed in a hot environment. The role of exercise in the appearance of signs and symptoms (SAS) of heat exhaustion has not been studied systematically, even though exercise and metabolic heat productions are often described as key factors in exertional heat stroke. In fact, controlled studies involving any severe form of human heat illness do not exist, and our understanding of heat exhaustion arises primarily form prospective or anecdotal reports. The (SAS) of heat exhaustion were reported for 14 healthy males, who underwent 8 days of strenuous exercise at 41.2°C (100 min/day). Twelve out of 14 subjects experienced one or more SAS (20 out of 112 trials). SAS were reduced during the course of heat acclimation, and were not correlated with physical characteristics such as height, mass, and VO_2max.

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Furthermore, physiological measurements taken at the time of premature termination of trials (39.5°C rectal temperature) indicated that it was unlikely that subjects perceived hyperthermia as a threat to their well-being.

We have employed the primed constant infusion technique to investigate the metabolic effects of the organophosphate antidote atropine, on glucose homeostasis in rats. This method utilized the radioisotopes 6-^{3}H-glucose to measure production and uptake and U-^{14}C-glucose to measure oxidation. Our data indicate that glucose production significantly increased (24.0±2.0 vs 30.9±2.6 umoles/kg.min) following atropine administration. The elevated rate of glucose turnover was associated with concomitant increases in glucose oxidation (8.3±.6 vs 12.0±.8 umoles/kg.min), the % of glucose uptake oxidized (37.2±2.0 vs and the % carbon dioxide produced from glucose (8.4±.7 vs 12.0±1.8). Presumably, these glucokinetic changes were mediated by elevated plasma catecholamines (Epi: 166±19 vs 271±50 pg/ml; Norepi: 262±24 vs 525±63 pg/ml, $p<0.05$) since other glucoregulatory hormones (insulin, glucagon, and corticosterone) were unaffected by atropine administration. In addition, there was no change in VO_2 associated with atropine administration. These data indicate that atropine enhances glucose production and utilization; such effects could be ergogenic during exercise in thermoneutral conditions.

Modification of a non-invasive, one-step rebreathing technique for measuring cardiac output in humans during rest and exercise was completed. We substituted a high flow rate analyzer for a low flow rate mass spectrometer, reduced the length of sampling tubing to the analyzer and then designed and added a recirculation circuit from the exhaust outlet of the analyzer to an inlet at the base of the rebreathing bag. With these changes, the subject's expired gas was recirculated during the rebreathing maneuver without loss of bag volume. A unique feature of our method is that the subject's tidal volume is measured prior to the maneuver and then used as the bag volume. Varying the bag volume by 0.2L from the tidal volume had no significant effect on the estimate of cardiac output. Using tidal volume as bag volume and rebreathing frequencies of 27-40 min $^{-1}$, we obtained results that were highly reproducible on a daily basis. Because our modifications were quick, reliable and noninvasive, measures of cardiac output are feasible in heat-injured and

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dehydrated troops not only in the lab but also in the field.

Dehydration increases with poor palatability of drinking water, insufficient time for consumption, increased rate, and difficulty in obtaining water. When wearing chemical protective gear, drinking is further limited and marked dehydration may be a significant problem for the working soldier. Fluid balance and performance measures were studied in 15 male soldiers walking at 4.7 km/h on a treadmill for six consecutive 50/10 minute work/rest cycles. Chamber conditions simulated a temperate climate (30°C d.b., 18°C w.b.) and water (30°C) was consumed ad libitum. On one day soldiers wore the Battle Dress Uniform (BDU) and drank from canteens, and on a second day, they were in MOPP IV and used either the current (CS) or a hand pump driven fluid hydraulics (FF) water delivery system. All subjects wearing BDU completed the 300 minutes of exercise. During exercise, they consumed 0.25±0.05 L/hr to partially compensate for average sweat losses of 0.37 L/hr, contributing to body weight deficits of 0.24±0.02 kg/hr. Compared to the BDU group, both CS and FF groups consumed more water during the exercise periods (0.28±0.04 L/hr and 0.42± 0.06 L/hr), with CS drinking significantly less than FF. Because sweat losses were also greatly increased in CS and FF groups (0.84 L/hr), body weight deficits were double those of BDU. This may account for the performance decrements in the CS and FF trials in which an average of 210 and 231 minutes, respectively, out of a possible 300 exercise minutes were completed. When in MOPP IV only 37% using CS and 43% using FF completed the six exercise bouts. Moreover, soldiers using either CS or FF perceived more symptoms of hyperthermia and dehydration. These results indicated that the fluid hydraulics system of water delivery provided modestly increased drinking during work over the current gravity driven system. The FF system of water delivery may elicit increased drinking thus reducing the physiological cost of work in the heat and improving physical performance in the heat.

The Botsball or WGT (Wet Globe Thermometer) has been widely distributed to military users as a rugged, simple, and inexpensive alternative to WBGT (Wet Bulb-Globe Temperature) instruments. Existing hot weather guidelines for the Botsball presumed that the Botsball would always read approximately 2°F (1.6°C) lower than the prevailing WBGT index. Following reports from the field of

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Botsball readings as much as 10°F (5.6°C) lower than the prevailing WBGT index during hot, dry, and windy conditions, a wind tunnel study was conducted to assess Botsball performance characteristics over a broad range of temperatures humidities, and wind speeds (USARIEM Technical Report No. T9/86). The wind tunnel study confirmed that substantial and potentially dangerous underestimates of heat stress on the order of 11°F (6.1°C) may be obtained with the Botsball under very hot, dry, and windy conditions. In an effort to derive a practical correction process that would, with reasonable precision, correct the Botsball reading to parity with the prevailing WBGT index, the wind tunnel data were reexamined. A mathematical relationship incorporating one additional measurement, DB (Dry Bulb) was found to provide an average bias (D) of -0.1°F (0.06°C) with a variation (±2 Standard Deviations) of ±1.6°F (0.9°C) around that bias. The equation derived from the wind tunnel study, was: WBGT = 0.8 X Botsball Reading + 0.2 X DB + 1.3°F (0.7°C). The present study was conducted to determine the reliability of the correction procedure in natural heat stress environments. Performance of the correction procedure was assessed in both desert and jungle environments in Australia in February 1987. Using the correction equation and a DB measurement obtained from the dial thermometer component of the Botsball itself, overall bias (D) was found to be +2.6°F (1.4°C) and the precision estimate (±2SD) was ± 2.9°F (1.6°C).

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PRESENTATIONS

Armstrong, L.E. High and dry: The effects of hyperthermia and dehydration of human performance. Seminar Lecture, New England American College of Sports Medicine Annual Meeting, Worcester, MA, November, 1987.

DeLuca, J., L. Armstrong, P. Szlyk, E. Christensen, R. Hubbard, and M. Foley. Evaluation of a head cooling garment during exercise in the heat. Free communication, New England American College of Sports Medicine Annual Meeting, Worcester, MA., 1987.

Hubbard, R., C. Matthew, M. Durkot, and R. Francesconi. Novel approaches to the pathophysiology of heatstroke: The energy depletion model. Presented at the 4th Annual UA/EM-ARIEM Research Symposium: Environmental Emergencies. Tampa, Florida, Feb 24, 1987.

Roger W. Hubbard, Ph.D. Heat Stroke. Core program 4th Annual Meeting, AMSUS. Las Vegas, NV, November 1987.

Roger W. Hubbard, Ph.D. Heat illness management: New theory of the pathophysiology of heat stroke at the cellular level. Wilderness and environmental emergencies conference. Dartmouth-Hitchcock Medical Center, Hanover, NH, December 1987.

KEY BRIEFINGS

Lawrence E. Armstrong, CPT, Ph.D. Desert & jungle survival for the Army aviator. Aviation Safety Workshop: 26 Avn Bde/Otis AFB, Bedford, MA, March 1987.

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KEY BRIEFINGS

Lawrence E. Armstrong, CPT, Ph.D. Water Delivery Systems in MOPP IV, Commander, MG Drummond, CG. Operational Test & Evaluation Agency, USARIEM, Natick, MA, April 1987.

Lawrence E. Armstrong, CPT, Ph.D. Heat injury: Predisposition, recognition and prevention. Medical Staff Seminar, Ireland Army Hospital, Ft. Knox, KY, April 1987.

Lawrence E. Armstrong, CPT, Ph.D. Military perspective on heat acclimatization and heat illness: Diagnosis, treatment, prevention. Current Concepts In Environmental Medicine Course, USARIEM, Natick, MA, May 1987.

Lawrence E. Armstrong, CPT, Ph.D. Thermoregulatory evaluation of former heat stroke patients. Medical staff, Martin Army Hospital, Ft. Benning, GA, June 1987.

Lawrence E. Armstrong, CPT, Ph.D. Leadership responsibilities in prevention of heat injury and training. Fifth U.S. Army Reserves, Annual Conference, Oklahoma City, OK, August 1987.

Lawrence E. Armstrong, CPT, Ph.D. Heat Illness: Considerations for the flight surgeon. Aeromedical Center, Lyster Hospital, Dothan, AL, March, 1987 July, and November 1987.

Ralph P. Francesconi, Ph.D. Prevention of heat injury. 101st Airborne Division, Ft. Campbell, KY, May 1987.

Ralph P. Francesconi, Ph.D. Diagnosis, prevention and treatment of heat injury, US Army MEDDAC, Ft. Campbell, KY, May 1987.

Ralph P. Francesconi, Ph.D. To deliver 9 briefings on the Prevention of Heat Injury and Army Operations in Desert Environments to NCO's, Officers and Medical personnel of the 101st Airborne, DN, Ft. Campbell, KY, May 1987

Ralph P. Francesconi, Ph.D. Prevention of heat injuries, MEDDAC, Ft. Devens, MA, June 1987.

Roger W. Hubbard, Ph.D. Briefing MEDDAC, Walsen Army Hospital, Ft. Dix, NJ, August 1987.

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KEY BRIEFINGS

Candace B. Matthew. Present seminar: "Heat-stress, exercise performance, and cholinergic pharmacology", USAMRICD, Edgewood, MD, March 1987.

Patricia C. Szlyk, Ph.D. Treatment of chemical agent casualties, 373rd General Hospital, Boston, MA, January 1987.

Patricia C. Szlyk, Ph.D. Fluid requirement and prevention of dehydration in MOPP IV, 373rd General Hospital, Boston, MA, November 1987.

Patricia C. Szlyk, Ph.D. Drinking, sleeping and urination in MOPP ensembles. 373rd General Hospital, Boston, MA, November 1987.

Patricia C. Szlyk, Ph.D. Voluntary Dehydration: Predisposition and prevention. USARIEM Current Concepts in Environmntal Medicine Course, Natick, MA, May 1987.

SIGNIFICANT TDY

Lawrence E. Armstrong, CPT, Ph.D. Evaluation of former heat stroke patients. Martin Army Community Hospital, Fort Benning, GA, June 1987.

Michael J. Durkot, Ph.D. Workshop on calorie dense rations, National Academy of Sciences, Washington, DC, February 1987.

Ralph P. Francesconi, Ph.D. To attend the Chemical Warfare Defense Technical Review. USAFSAM, San Antonio, TX, January 1987.

Ralph P. Francesconi, Ph.D. To attend US Government-NAS meeting on Research Associate Program, Washington, DC, April 1987.

Ralph P. Francesconi, Ph.D and Roger W. Hubbard, Ph.D. To attend meeting of the Scientists Center for Animal Welfare on "Well being of laboratory animals - How to comply with the new regulations", Chicago, IL, June 1987.

Roger W. Hubbard, Ph.D. Attend Joint Water Group Meeting on water purification, storage & distribution in cold weather environments, Ft. Lee, VA, May 1987.

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SIGNIFICANT TDY

Candace B. Matthew. Attend Chemical Warfare Defense Project 2729 Technical Review, Brooks AFB, TX, January 1987.

Candace B. Matthew and Ralph P. Francesconi, Ph.D. Attend Sixth Medical Bioscience Review, Johns Hopkins University Applied Physics Lab; Columbia, MD, August 1987.

William T. Matthew and SGT Glenn J. Thomas. Conduct tests of a correction procedure for WGT (Botsball) measurements of heat stress. North Queensland, and Northern Territory, Australia, February 1987.

Patricia C. Szlyk, Ph.D Attend 804th Hospital Center 19th Medical Symposium on Medical management of chemical casualties, Newton-Wellesley, MA, March 1987.

Patricia C. Szlyk, Ph.D Attend 804th Hospital Center 20th Medical Symposium on The cycle of medical care in nuclear warfare, Newton-Wellesley, MA, September 1987.

SIGNIFICANT VISITORS

Dr. John D. Baldwin, Gulf Weather Corp., St. Louis, MO, May 1987.

Dr. David L. Costill, Director, Human Performance Laboratory, Muncie, IN, November 1987.

PROFESSIONAL APPOINTMENTS/ACTIVITIES

Lawrene E. Armstrong, CPT, Ph.D. Reviewer, Aviation Space and Environmental Medicine, Medicine and Science in Sport and Exercise, International Journal of Sports Medicine, Physician and Sportsmedicine.

Lawrence E. Armstrong, CPT, Ph.D. Member USARIEM Human Use Review Committee.

Lawrence E. Armstrong, CPT, Ph.D. Executive Committee Member, New England Chapter, American College of Sports Medicine.

Lawrence E. Armstrong, CPT, Ph.D. Contracting Officer's Representative, DAMD17-86-C-6087, Tuskeegee University, AL.

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PROFESSIONAL APPOINTMENTS/ACTIVITIES

Michael J. Durkot, Ph.D. Member American Physiology Society.

Michael J. Durkot, Ph.D. Member, Quality Assurance Committee, USARIEM

Michael J. Durkot, Ph.D. Contracting Officer's Representative, DAMD17-87-7235, University of Chicago.

Ralph P. Francesconi, Ph.D. Reviewer, American Physiological Society, Journal Applied Physiology.

Ralph P. Francesconi, Ph.D. Chairman, Laboratory Animal Care and Use Committee, USARIEM.

Ralph P. Francesconi, Ph.D. Advisor, NAS/NRC Assciateship Program, USARIEM.

Ralph P. Francesconi, Ph.D. Member, Quality Assurance Committee, USARIEM.

Ralph P. Francesconi. Ph.D. Reviewer, Aviation Space Environmental Medicine.

Ralph P. Francesconi, Ph.D. Contracting Officer's Representative, DAMD17-85-C-5099, Purdue University.

Roger W. Hubbard, Ph.D. DOD Steering Committee on Field Water Quality.

Roger W. Hubbard, Ph.D. Adjunct Professor of Pathology, Boston University School of Medicine.

Roger W. Hubbard, Ph.D. Water Resources Management Action Group.

Roger W. Hubbard, Ph.D. Guest Reviewer. American Journal Physiology, Aviation Space and Environmental Medicine.

Roger W. Hubbard, Ph.D. Contracting Officer's Representative, DAMD-17-86-C-6167, Boston University.

William T. Matthew. Appointed to Hazardous Waste Minimization Board, USANRDC, Natick, MA.

Patricia C. Szlyk, Ph.D. Reviewer, Aviation Space Environmental Medicine.

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PROFESSIONAL APPOINTMENTS/ACTIVITIES

Patricia C. Szlyk, Ph.D. Contracting Officer's Representative, for Institute of Chemical Defense.

MILITARY ERGONOMICS DIVISION

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A prototype air-liquid hybrid microclimate cooling system, designed for use by combat vehicle crewmen, was tested to assess its ability to reduce heat stress during physical exercise while wearing the MOPP 4 protective configuration. The system was tested once in its air-cooled mode and once in its liquid cooled mode and compared with existing air and liquid cooled systems. Five subjects completed 120 minutes of walking at a metabolic rate of 332 watts in a 37.7°C db, 11.5°C dp environment in all experiments. There were no differences in final core temperature, heart rate or whole body sweating rate among the experiments. While all systems effectively cooled the subjects, the subjects did show significant increases between exercise bouts when wearing both the liquid system and liquid mode of the hybrid system. The subjects also had final mean weighted skin temperatures that were significantly higher than in all other systems when wearing the liquid mode of the hybrid system.

A study evaluated the effectiveness of an air-cooled vest in reducing thermal strain of subjects exercising in the heat (49°C dry bulb (db), 20°C dew point (dp) in chemical protective clothing. Four male subjects attempted 300-min heat exposures of two metabolic rates (175 and 315 W) with six cooling combinations--control (no vest) and five different db and dp combinations. Air supplied to the vest at 15 sfm ranged from 20-27°C db, 7-18°C dp; theoretical cooling capacities were 498-687 W. Without the vest, endurance times were 118 min (175 W) and 73 min (315 W). Endurance times with the vest were 300 min (175 W) and 242-300 min (315 W). The five cooling combinations were similarly effective in reducing thermal strain and extending endurance time, although there was a trend for the vest to be more effective when supplied with air at the lower dry bulb temperature. At 175 W, subjects maintained a constant body temperature; at 315 W, the vest's ability to extend endurance is limited to about five hours.

Three commercially produced microclimate cooling systems were evaluated for possible use by Army personnel. Five subjects dressed in the MOPP 4 protective configuration attempted 150 min of treadmill walking at 440 watts (180 min total exposure) in a 38°C db, 12°C dp environment. Cooling systems were ILC Dover Model 19 Coolvest (ILC); LSSI Coolhead (LSSI); Thermacor Cooling Vest (THERM). Total exposure time was greater with ILC (1787 min), was greater than THERM (131 min), which was greater than LSSI (83 min). All LSSI experiments were self terminated by the subjects with headaches. There was no difference in whole body sweating rate among the vests, based on pre- to post-exercise weight changes corrected for water intake. Further analyses

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were done on 60 minute values. There were no differences among either heart rate or core temperature values. The LSSI system had mean weighted skin temperature values, which were significantly lower than the THERM system.

A rational effective temperature (ET) was derived using a psychometric format to assess the relative thermoregulatory strain occurring during moderate exercise caused by antidotal treatment for organophosphate poisoning. Atropine plus pralidoxime increased ET by 4.1°C as compared to saline treatment while atropine or pralidoxime alone increased ET by 2.0°C. These data indicate that antidotal treatment for organophosphate poisoning significantly increased thermoregulatory strain during exercise than occurred with either drug alone.

The rate at which ingested fluids replenish body water stores is largely governed by the rate ingested fluids empty from the stomach to the intestines (gastric emptying rate) for absorption. Results of our recent research indicate that gastric emptying is reduced during exercise performed in the heat as compared to temperate conditions. Our results further demonstrate that gastric emptying is reduced in hypohydrated subjects during exercise in the heat. Reductions in gastric emptying appear to be related to the severity of the thermal strain induced by an exercise/heat stress. In a related experiment, gastric emptying was assessed during treadmill exercise (walking or running) performed over a wide range of intensities (28-75% $\dot{V}O_2$ max) and compared to resting conditions. Results from this experiment indicated that gastric emptying was similarly increased during both moderate intensity walking and running exercise, but reduced during high intensity running exercise. Increases in gastric emptying during moderate intensity treadmill exercise may be related to increases in intragastric pressure brought about by contractile activity of the abdominal muscles.

A study examined the effects of autologous erythrocyte infusion on blood volume and thermoregulation during exercise in the heat. By use of a double-blind design, nine unacclimated male subjects were infused with either 600 ml of a NaCl-glucose-phosphate solution containing a ~50% hematocrit or 600 ml of this solution only. A heat stress test (HST) was attempted ~2 wk pre- and 48 h post-infusion during the late spring months. Generally, no significant effects were found for the saline group. For the reinfusion group, RCV (11%, $P<0.01$) and $\dot{V}O_2$ max (11%, $P<0.05$) increased after infusion, and the

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following observations were made: a) the increased RCV was associated with a reduction in PV to maintain the same blood volume as during the pre-infusion measurements; b) polycythemia reduced total circulating protein but did not alter F-cell ratio, plasma osmolality, plasma protein content, or plasma lactate at rest or during exercise-heat stress; c) polycythemia did not change the volume of fluid entering the intravascular space from rest to exercise-heat stress; and d) polycythemia tended to reduce the rate of heat storage during exercise-heat stress.

Induced erythrocythemia is associated with a variable increase in maximal oxygen uptake. We examined the roles of the magnitude of change in hemoglobin concentration and the individual's initial aerobic fitness on this effect. Freeze-preserved erythrocytes from the product of 2 units of blood were reinfused, and maximal oxygen uptake was measured with 24 to 72 hours after reinfusion. The data for 30 subjects analyzed had an initial aerobic power of 36 to 88 ml of oxygen per kilogram per minute. The combined results from these studies indicate that after erythrocyte reinfusion a) the increase in hemoglobin concentration is fairly homogeneous (mean ± SD, 1.36 ± 0.6 g/dl); b) nearly all individuals demonstrate an increase in maximal oxygen uptake (0.357 ± 0.216 l/min); c) the magnitude of increase in hemoglobin concentration is not related to the magnitude of increase in maximal oxygen uptake; and d) the magnitude of increase in maximal oxygen uptake is related to the individual's initial aerobic fitness. Individuals with an initial aerobic fitness between 50 and 65 $ml \cdot kg^{-1} \cdot min^{-1}$ experience approximately twice the increase in maximal oxygen uptake after erythrocyte reinfusion of individuals with greater fitness and also of lesser fitness.

Sleep deprivation is known to decrease resting body temperature after as little as 33 hours without sleep. The normal circadian variation in body temperature is associated with an altered core temperature threshold for heat loss (i.e., onset for sweating and cutaneous vasodilation). Therefore, we evaluated the decrease in resting core temperature following 33 hours of wakefulness and found an attenuation in the sensitivity of skin blood flow and local sweating to increasing esophageal temperature during exercise. In addition, a slight lowering of the vasodilatory threshold was associated with the decrease in core temperature. In general, the decrease in core temperature after sleep loss is not regulated in an identical manner as the normal circadian rhythm in core temperature.

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

The purpose of this experiment was to determine whether moderate dehydration affected plasma volume responses to maximal exercise on a cycle ergometer. After moderate dehydration the previous day, the plasma volume (PV) responses to maximal exercise of four subjects who were not acclimatized to heat were studied. PV equilibrated after dehydration (5% of body weight) to a level which was not significantly different from control at rest. After maximal exercise, PV was not significantly different between the control and dehydrated conditions. The increased tonicity of moderate dehydration did not affect PV dynamics during recovery from maximal exercise.

Little information is available on the effects of varied metabolic substrate levels on the ability to rewarm following cold exposure. With this in mind, we examined the influence of depleted muscle glycogen levels on the passive rewarming responses subsequent to mild hypothermia (35.5°C). Eight subjects completed two cold water immersions followed by 75 min of passive rewarming (resting in blankets, 22°C air temperature). Rewarming increased body core temperatures similarly during both experiments. Furthermore, no significant differences were found in the amount of afterdrop (defined as a continued decline in core temperature during the initial period of rewarming) that occurred during either experiment. Thus, these results indicate that low muscle glycogen levels do not impair rewarming time nor alter afterdrop responses during passive rewarming following mild to moderate hypothermia.

A requirement for an interim field portable prototype thermal model of a human hand was developed into a contract proposal which was accepted and funded. Without this action, the Biophysics Branch would have lost its capability to perform biophysical evaluations of handwear, a critical clothing item. The "weatherproof" specification of the prototype will allow evaluation of wet handwear and important field capabilities relative to soldier performance in cold-wet environments.

Biophysical evaluations were finished on cold weather footwear, handwear and clothing properties. The latter included copper manikin assessments of enhanced chemical protective suits, chemical overgarments with attached permeable hoods and Air Force chemical defense prototypes. All showed evaporative potential between 12 to 17% at most.

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Fourteen requests for heat stress prediction model evaluations were completed.

A human cold-water immersion thermoregulatory model was successfully completed. A procedure was developed for matching the predictive equations and measured initial values of deep body temperature and metabolic rate, which now allows the user to more accurately determine the thermoregulatory set-point values. This model allows the user to circumvent the errors in prediction of convective heat loss due to acute sensitivity to the skin-water temperature differences. The model is an initial step in development of an overall prediction model usable for cold air and cold water exposure with various metabolic activities, cold acclimation states and clothing ensembles.

Evaluations on 22 different underwear fabrics were conducted to determine resistance to dry heat and water vapor transfer. Results indicate that the new commercially-available polyesters (Capilene and Thermax) may offer higher levels of sweat dissipation than the current ECWCS underwear (100% fleece polypropylene) or the standard winter-issue underwear (50% cotton/50% wool). These evaluations were useful in the selection of underwear made from both natural and synthetic fibers and various knit structures for use in a human study investigating the role of clothing in the development of after-exercise cooling.

The physiological effects of different textile materials and knit structures used in the underwear of a combat ensemble were studied in the development of over-heating or cooling in soldiers during intermittent exercise in a cold environment. No significant differences could be detected in responses of esophageal temperature, skin temperature, skin wettedness and onset time of sweating in winter-issue underwear constructed from two natural fibers (cotton, wool) and two synthetic fibers (polypropylene, polyester). Knit structure of this underwear did have a significant influence on thermoregulatory responses. Polypropylene underwear constructed in a dense fleece knit decreased the development of after-exercise chill during rest despite the fact that sweat rates were increased during exercise.

Biophysical and physiological evaluation of three distinct military handwear (Light-Duty and Heavy-Duty Work Gloves and the Arctic Trigger Finger Mitten) for use with the Extended Cold Weather Clothing System (ECWCS) was completed.

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

This study served to define tolerance limits of soldiers wearing these gloves while sedentary and exercising in moderate and extreme cold environments. The three gloves provided hand protection and overall cold tolerance relative to their measured intrinsic insulation. At 0°C tolerance time was near maximum (120 min) for all gloves during both activities. Tolerance times were greatly reduced while sedentary at -30°C (25 min with the Light-Duty and 46 min with the Heavy-Duty glove). This was the first study to employ the ECWCS over an extended exposure and activity mode. Skin and rectal temperature responses indicate that the ECWCS offers protection through a wide temperature range which would allow extension into more temperate climates when ventilation and removal of clothing layers is an option during strenuous exercise.

ECWCS was also worn during another completed study designed to evaluate cold tolerance of petroleum, oil-lubricant handlers' handwear. The specified performance criterion was 6 min of simulated fuel pumping at a given chamber air temperature. The pumping activity was preceded by a 10 min standing baseline. At -28.9°C (-20°F) 6 of 6 subjects met the basic criterion without experiencing acute discomfort or a finger surface temperature below 5°C (41°F). At -34.4°C (-30°F), only 2 of 7 subjects were able to complete the initial 6 min of pumping.

A physiological/biophysical study was completed on evaluation of an attached 70-mil permeable hood to the standard overgarment. This study allowed evaluation of M-40 and M-17 respiratory masks by a human physiological evaluation as well as in hot-humid and hot-dry environments with wind (up to 5 $m \cdot s^{-1}$). In general, it appears that the use of a 70-mil permeable hood integrated to a standard overgarment offers no significant advantages compared to a standard BDO in reduction of heat strain, extension of endurance times, or in improvement in vapor permeation to a given clo insulation. At most only a 10-12% increase in the ratio of evaporative heat loss to sweating rate occurred at high air movement. Although carbon-lined hoods offer an optimal chemical protection for the head region, the use of a butyl hood with the M-40 mask suggests a preferable heat transfer option because of the reduced thickness of the hood (about 9 times less than the permeable hood) which offers an augmented i_m/clo with high wind speeds.

MILITARY ERGONOMICS DIVISION

PUBLICATIONS:

Engell, D.B., O. Maller, M.N. Sawka, R.P. Francesconi, L.L. Drolet and A.J. Young. Thirst and fluid intake following graded hypohydration levels in humans. Physiol. Behav. 40:229-236, 1987.

Gonzalez, R.R. Biophysical and physiological integration of proper clothing for exercise. In: Exercise and Sport Sciences Reviews. K.B. Pandolf (Ed.), Macmillan Publishing Company, New York, NY, 1987, pp. 261-295.

Kolka, M.A., L.A. Stephenson, S.P. Bruttig, B.S. Cadarette and R.R. Gonzalez. Heat exchange after atropine and pralidoxime administration. Aviat. Space Environ. Med. 58:762-767, 1987.

Kolka, M.A., L.A. Stephenson, P.B. Rock and R.R. Gonzalez. Local sweating and cutaneous blood flow during exercise in hypobaric environments. J. Appl. Physiol. 62:2224-2229, 1987.

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Moore, L.G., A. Cymerman, H.S. Huang, R.E. McCullough, R.G. McCullough, P.B. Rock, A.J. Young, P.M. Young, J.V. Weil and J.T. Reeves. Propranolol blocks the increase in resting metabolic rate but not ventilatory acclimatization to 4300 m. Resp. Physiol. 70:195-205, 1987.

Muza, S.R., M.N. Sawka, A.J. Young, R.C. Dennis, R.R. Gonzalez, J.W. Martin, K.B. Pandolf and C.R. Valeri. Elite Special Forces: Physiological description and ergogenic influence of blood reinfusion. Aviat. Space Environ. Med. 57:1000-1004, 1987.

Nielsen, R. Field assessment of thermal indices for moderate cold environments. In: Trends in Ergonomics/Human Factors IV. S.S. Asfour (Ed.), Elsevier Science Publishers B.V. (North Holland), 1987, pp. 383-390.

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MILITARY ERGONOMICS DIVISION

PUBLICATIONS:

Pandolf, K.B. (Ed.) Exercise and Sport Sciences Reviews (Vol. 15). Macmillan Publishing Company, New York, NY, 1987, 479 pages. ISBN:0-02-390600-6.

Pandolf, K.B., M.N. Sawka and Y. Shapiro. Factors which alter human physiological responses during exercise-heat acclimation. In: Adaptation Physiology to Stressful Environments. S. Samueloff and M.K. Yousef, (Eds.), CRC Press, Boca Raton, 1987, pp. 91-102.

Pandolf, K.B., A.E. Allen, R.R. Gonzalez, M.N. Sawka, L.A. Stroschein and A.J. Young. Auxiliary cooling experimental results. Handbook on Clothing: Biomedical Effects on Military Clothing and Equipment Systems. RSG 7 of NATO Panel VIII, 1987.

Pandolf, K.B., M.M. Toner, W.D. McArdle, J.R. Magel and M.N. Sawka. Influence of body mass, morphology and gender on thermal responses during immersion in cold water. Proceedings of 9th International Symposium on Underwater and Hyperbaric Physiology. In: Underwater and Hyperbaric Physiology. A.A. Bove, A.J. Bachrach and L.J. Greenbaum, Jr. (Eds.), McGregor and Werner, Inc., Bethesda, MD, 1987, pp. 145-152.

Pandolf, K.B., A.E. Allen, R.R. Gonzalez, M.N. Sawka, L.A. Stroschein and A.J. Young. Chemical warfare protective clothing: Identification of performance limitations and their possible solution. In: Trends in Ergonomics/Human Factors. S.S. Asfour (Ed.) North Holland, New York, 1987, pp. 397-404.

Pandolf, K.B. Importance of environmental factors for exercise testing and exercise prescription. In: Exercise Testing and Exercise Prescription for Special Cases - Theoretical Basis and Clinical Application. J.S. Skinner (Ed.), Lea and Febiger, Philadelphia, 1987, pp. 77-98.

Pimental, N.A., H.M. Cosimini, M.N. Sawka and C.B. Wenger. Effectiveness of an air-cooled vest using selected air temperature and humidity combinations. Aviat. Space Environ. Med. 58:119-124, 1987.

Reams, W.H., P.R. Snow, W.T. Taylor, L.A. Stephenson and D.T. George. Chemical warfare agent protective patient wrap. In: Proceedings of the Sixth Annual Medical Chemical Defense Bioscience Review, 1987, pp. 519-523.

MILITARY ERGONOMICS DIVISION

PUBLICATIONS:

Rose, M.S., R.P. Francesconi, L. Levine, B. Shukitt, A.V. Cardello, P.H. Warren, I. Munro, L. Bandaret, P.M. Poole, P. Frykman and M.N. Sawka. Effects of NBC nutrient solution during 24 hours of sustained activity. USARIEM Technical Report No. T/25, 1987.

Sawka, M.N., A.J. Young, S.R. Muza, R.R. Gonzalez and K.B. Pandolf. Erythrocyte reinfusion and maximal aerobic power: An examination of modifying factors. J. Amer. Med. Assoc. 257:1496-1499, 1987.

Sawka, M.N., A.J. Young, S.R. Muza, R.R. Gonzalez and K.B. Pandolf. Transfusion autologue de globules rouges et puissance aerobie maximale. J. Amer. Med. Assoc. (E'dition Francaise). 146:715-716, 1987.

Sawka, M.N., R.C. Dennis, R.R. Gonzalez, A.J. Young, S.R. Muza, J.W. Martin, R.P. Francesconi, C.B. Wenger, K.B. Pandolf and C.R. Valeri. Influence of polycythemia on blood volume and thermoregulation during exercise-heat stress. J. Appl. Physiol. 62:912-918, 1987.

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Stephenson, L.A., M.A. Kolka, A.E. Allan, W.R. Santee and R.R. Gonzalez. Heat exchange during encapsulation in a chemical warfare agent protective patient wrap. In: Proceedings of the Sixth Annual Chemical Defense Bioscience Review, 1987, pp. 529-532.

Stephenson, L.A., M.A. Kolka, A.E. Allan and W.R. Santee. Heat exchange during encapsulation in a chemical warfare agent protective patient wrap in four hot environments. USARIEM Technical Report No. T10/87, 1987.

Tikuisis, P., R.R. Gonzalez and K.B. Pandolf. Human thermoregulatory model for whole body immersion in water at 20 and 28°C. USARIEM Technical Report No. T/23, 1987.

Young, A.A., S.R. Muza, M.N. Sawka and K.B. Pandolf. Human vascular fluid responses to cold stress are not altered by cold acclimation. Undersea Biomed. Res. 14:215-228, 1987.

MILITARY ERGONOMICS DIVISION

PUBLICATIONS:

Young, A.J., M.N. Sawka, Y. Epstein, B. DeCristofano and K.B. Pandolf. Cooling different body surfaces during upper- and lower-body exercise-heat stress. J. Appl. Physiol. 63:1218-1223, 1987.

Young, A.J., S.R. Muza, M.N. Sawka and K.B. Pandolf. Cold acclimation can be induced in humans by repeated cold water immersion. In: Underwater and Hyperbaric Physiology. A.A. Bove, A.J. Bachrach and L.J. Greenbaum, Jr. (Eds.). McGregor and Werner, Inc., Bethesda, MD, 1987, pp. 109-119.

ABSTRACTS:

Cadarette, B.S., A.J. Young, M.N. Sawka, Y. Epstein, B. DeCristofano and K.B. Pandolf. Cooling different body surfaces during upper and lower body exercise. Aviat. Space Environ. Med. 58:495, 1987.

Gonzalez, R.R., M.N. Sawka, A.J. Young, S.R. Muza, W.A. Latzka, R.C. Dennis, C.R. Valeri and K.B. Pandolf. Erythrocyte reinfusion in heat acclimated males before and after 5% hypohydration improves sweating responses. The Physiologist 30:205, 1987.

Kolka, M.A. and L.A. Stephenson. Forearm cutaneous blood flow after sleep loss. Fed. Proc. 46:1440, 1987.

Kolka, M.A., L.A. Stephenson, A.E. Allan and P.B. Rock. Atropine lowers body temperature during exercise in a cool environment. The Physiologist 30:147, 1987.

Latzka, W.A., S.R. Muza, L. Levine and K.B. Pandolf. Comparison of rated perceived exertion and constant effort during muscular exercise. Med. Sci. Sports Exerc. 19:S79, 1987.

Muza, S.R., L. Levine, W.A. Latzka and M.N. Sawka. Ventilatory responses to loaded breathing during submaximal exercise. Fed. Proc. 46:501, 1987.

Neufer, P.D., A.J. Young, M.N. Sawka and J. Buchbinder. Influence of skeletal muscle glycogen on passive rewarming after hypothermia. Med. Sci. Sports Exerc. 19:58, 1987.

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ABSTRACTS:

Pandolf, K.B., M.N. Sawka, A.J. Young, S.R. Muza and R.R. Gonzalez. Erythrocyte reinfusion and maximal aerobic power: an examination of modifying factors. Fed. Proc. 46:678, 1987.

Sawka, M.N., R.R. Gonzalez, A.J. Young, S.R. Muza, K.B. Pandolf, W.A. Latzka, C.R. Valeri and R.C. Dennis. Effects of acute polycythemia and hydration on blood volume and exercise-heat performance. The Physiologist 30:205, 1987.

Stephenson, L.A., M.A. Kolka and A.E. Allan. Moderate dehydration does not affect plasma volume loss during maximal exercise. The Physiologist 30:133, 1987.

Tikuisis, P., R.R. Gonzalez and K.B. Pandolf. Predicted endurance times for nude immersion in water at 20°C and 24°C. Aviat. Space Environ. Med. 58:515, 1987.

Young, A.J., S.R. Muza, P.D. Neufer, J. Bogart and K.B. Pandolf. Muscle metabolism during prolonged shivering. Med. Sci. Sports Exerc. 19:S8, 1987.

PRESENTATIONS:

Gonzalez, R.R. Determination of proper clothing for exercise: Biophysical and physiological factors. Second International Symposium on Protective Clothing, Tampa, FL, January 1987.

Pandolf, K.B. Effects of environmental factors (heat and cold) on physiological responses to exercise and extrapolation to emotional responses. 18th Annual Meeting of the Biofeedback Society of America, Boston, MA, March 1987.

Pandolf, K.B. Chemical warfare protective clothing: Identification of performance limitations and their possible solution. Annual International Industrial Ergonomics and Safety Conference, Coral Gables, FL, June 1987.

Pandolf, K.B. Human performance at environmental extremes. Sports-Biology Colloquium at Springfield College, Springfield, MA, February 1987.

Sawka, M.N. Fluid and electrolyte distribution in thermal stress. American Physiological Society Symposium, Washington, DC, April 1987.

MILITARY ERGONOMICS DIVISION

PRESENTATIONS:

Sawka, M.N. Effects of exercise and body fluid manipulation in the heat. Fluids and Electrolyte Distribution in Thermal Stress Symposium. American Physiological Society Symposium, Federation of American Societies for Experimental Biology Meeting, Washington, DC, April 1987.

KEY BRIEFINGS:

Michael N. Sawka, Ph.D. Importance of plasma and erythrocyte volume during exercise-heat stress; Naval Blood Research Laboratory/Boston University School of Medicine, Boston, MA, March 1987.

Clement A. Levell Air Force chemical protective suits; Test Plan Working Group (TPWG) for Chemical Defense Aircrew Ensemble Program, Wright-Patterson AFB, Ohio, April 1987.

Leander A. Stroschein Heat stress prediction model; TROSCOM/USAIS Program Review, Natick, MA, October 1987.

Michael N. Sawka, Ph.D. Autologous erythrocyte reinfusion and human performance during exercise and environmental extremes; Army Medical Department Technical Committee, Falls Church, VA, December 1987.

Michael N. Sawka, Ph.D. Integrated physiological responses to muscular exercise; MGH Institute of Health Professions, Massachusetts General Hospital, Boston, MA, December 1987.

Leslie Levine NBC nutrient solution study findings; Military Nutrition Research Committee, National Research Council, USARIEM, Natick, MA, December, 1987.

SIGNIFICANT VISITORS:

Dr. Jean-Louis Bruchig, Paul Boyce Inc., France.

Dr. Samuel Brinton, Technical Director, W.L. Gore and Associates, Elkton, MD.

Dr. David Barnett, Technical Director, Batelle Pacific Inc., Washington.

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SIGNIFICANT VISITORS:

Dr. Brian Farnworth, Clothing and Textile Branch, National Research Council, Ottawa, Canada.

Mr. Dan Moran, Military Physiology Unit, Heller Medical Institute, Tel Hashomer, Israel.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Richard R. Gonzalez, Ph.D., Adjunct Professor, Environmental Science and Physiology, Harvard School of Public Health, Harvard Medical School, Boston, MA.

Kent B. Pandolf, Ph.D., Adjunct Professor or Health Sciences, Department of Health Sciences, Sargent College of Allied Health Professions, Boston University, Boston, MA.

Kent B. Pandolf, Ph.D., Adjunct Professor of Environmental Medicine, Springfield College, Springfield, MA.

Kent B. Pandolf, Ph.D., Editor, Exercise and Sport Sciences Reviews.

Kent B. Pandolf, Ph.D., Editorial Board Member, Medicine and Science in Sports and Exercise.

Kent B. Pandolf, Ph.D., Editorial Board Member, Ergonomics.

Michael N. Sawka, Ph.D., Adjunct Associate Professor, Department of Physical Therapy, Sargent College of Allied Health Professions, Boston University, Boston, MA.

C. Bruce Wenger, M.D., Ph.D., Visiting Research Associate in Physiology, School of Public Health, Harvard University.

C. Bruce Wenger, M.D., Ph.D., Working Group 11, Subcommittee C95.1-IV, American National Standards Institute.

C. Bruce Wenger, M.D., Ph.D., Teaching Staff, Harvard University Extension School.

Andrew J. Young, Ph.D., Member of the Public Relations Committee of the American College of Sports Medicine.

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MILITARY
NUTRITION RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Developed a method of determining nutrient intakes using a modified visual estimation method (MVEM) for dietary assessments. The Technical Report (No. T/6) contains a detailed description of the MVEM, the standardized procedures for training data collectors to be >90% reliable, to be accurate to within a tenth of a standard portion, and the procedures for analyzing the nutritional data by computer. Using MVEM and observing recipe preparation procedures improve the accuracy of the nutritional analysis information for population dietary assessments.

Determined the effects of the NBC Nutrient Solution on: nutritional status, thermoregulation during exercise in the heat, endurance capacity, vigilance, muscle strength, solution acceptability, cognitive states, motor performance skills, mood, and subjective reactions during sustained activity. The results of this study indicated that water and the NBC Nutrient solution were equally effective for 12 hours in maintaining hydration and physiological status under hot dry conditions. The NBC Nutrient solution was more palatable, lowered symptom intensity, and improved mood; cognitive performance was not improved.

Reviewed the question of high fat content of the Nutrition Sustainment Module (NSM) diets with recognized nutrition/health experts under the auspices of the NAS/NRC Food and Nutrition Board Committee on Military Nutrition. This guidance was provided to the Food Engineering Directorate of the USANREC, Natick, to incorporate in the NSM development program.

Tested the intrinsic metabolic value of fat calories in low and high fat NSM prototypes. Found that for periods of up to five days duration the amount of fat calories was not critical to physical performance, provided the diet contained a critical minimum carbohydrate content of approximately 400 gms.

Completed the third in a continuing series of nutrition assessments of soldiers subsisting in military dining facilities. The purpose of these studies is to evaluate the impact of nutrition initiatives planned to moderate soldiers' sodium, fat and cholesterol intakes and to provide soldiers with low calorie menu selections. In August 1987, the third nutrition assessment was completed using 54 male soldier volunteers from Ft, Devens, Massachusetts. Nutrient intakes were assessed by comparing average daily nutrient intakes,

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NUTRITION RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

expressed as group means, with the Office of the Surgeon General (OTSG) Military Recommended Dietary Allowances (MRDA AR 40-25). Nutrient intakes of the Ft. Devens test subjects met or exceeded the MRDA for energy, protein, vitamins, and minerals. Average sodium intakes for the test subjects of 1674 milligrams per 1000 kcals were within the OTSG guidelines of 1400-1700 mg sodium per 1000 kcals. Approximately 10% of total sodium was obtained from salt added by the test subjects. Test subjects' fat intakes, 38.2% of total calories, were approximately three percent higher than what was reported for similarly aged males in the 1985 Nationwide Food Consumption Survey, and exceeded the target level recommended by the American Heart Association and National Cholesterol Education Program of less than 300 mg per day. Fifty to sixty percent of total daily cholesterol was obtained at breakfast meals with egg entrees contributing 70-80% of breakfast cholesterol and 50-60% of total daily cholesterol. Attention should be focused on reducing cholesterol intakes at the breakfast meal.

Nutrient intakes of simulated patients and staff consuming regular diets as part of the Concept Evaluation Program for the Combat Field Feeding System (Medical) were adequate; however, patients consuming modified diets had inadequate intakes. An additional study of longer duration, with better instructions for participants, and without participant access to outside food sources was indicated.

PUBLICATIONS:

Askew, E.W., I. Munro, M.A. Sharp, S. Siegel, R. Popper, M.S. Rose, R.W. Hoyt, J.W. Martin, K. Reynolds, H.R. Lieberman, D. Engell, C.P. Shaw. Nutritional status and physical and mental performance of special operations soldiers consuming the ration lightweight or the meal, ready-to-eat military field ration during a 30-day field training exercise. USARIEM Technical Report No. T/7, 1987.

Askew, E.W. J.R. Claybaugh, G.M. Hashiro, W.S. Stokes, A. Sato, and S.A. Cucinell. Mauna Kea III: Metabolic effects of dietary carbohydrate supplementation during exercise at 4100 M altitude. USARIEM Technical Report No. T/12, 1987.

Buchbinder, J., J. Pocost, L. Hodgess, E. Roche, M. Rose, E. Askew, A. Young, D. Neufer. Manipulation of muscle glycogen concentrations using high and low carbohydrate diets and exercise. USARIEM Technical Report No. T/32, 1987.

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NUTRITION RESEARCH DIVISION

PUBLICATIONS:

Carlson, D.E., T. Dugan, J.C. Buchbinder, J. Allegretto, and D.D. Schnakenberg. Nutritional assessment of the Ft. Riley non-commissioned officer academy dining facility. USARIEM Technical Report No. T/14, 1987.

Engell, D.B., D.E. Roberts, E.W. Askew, M.S. Rose, J. Buchbinder, and M.A. Sharp. Evaluation of the ration, cold weather during a 10-day cold weather field training exercise. USANRDEC/USARIEM Technical Report No. TR-87/030, 1987.

Glassford, D.L., A.M. Ponsioen, C. Prevo, and E.P. Szeto. Concept evaluation program (CEP) test of the combat field feeding system, (medical). US Army Medical Dept Board, AHS, Fort Sam Houston, TX. Project No. 4/86, 1987.

Roberts, D.E., E.W. Askew, M.S. Rose, M.A. Sharp, S. Bruttig, and J.C. Buchbinder. Nutritional and hydration status of special forces soldiers consuming the ration, cold weather or the meal, ready-to-eat ration during a ten day cold weather field training exercise. USARIEM Technical Report No. T/8, 1987.

Rose, M.S., C.S. Houston, C.S. Fulco, G. Coates, D.E. Carlson, J.R. Sutton, and A. Cymerman. Operation Everest II: Effects of a simulated ascent to 29,000 feet on nutrition and body composition. USARIEM Technical Report No. T/15, 1987.

Rose, M.S., J.C. Buchbinder, T.B. Dugan, E.G. Szeto, J.D. Allegretto, R.W. Rose, D.E. Carlson, K.W. Samonds, and D.D. Schnakenberg. Determination of nutritional intakes by a modified visual estimation method and computerized nutritional analysis for dietary assessments of military field and garrison feeding. USARIEM Technical Report No. T/6, 1987.

Rose, M.S., R. Francesconi, L. Levine, B. Shukitt, A. Cardello, P. Warren, I. Munro, L. Banderet, P. Poole, P. Frykman, and M. Sawka. Effects of a NBC nutrient solution on physiological and psychological status during sustained activity in the heat. USARIEM Technical Report No. T/25, 1987.

Siegel, S.F., P.M. Poole, E.W. Askew, M.A. Kinney, C. Shaw, J. Aylward, and S. Hunter. Twelve-day field test of ration, lightweight, 30-day at Ft. Chaffee, AR., USANRDEC/USARIEM Technical Report No. TR-87/032, 1987.

Szeto, E.G., D.E. Carlson, T.B. Dugan, J.C. Buchbinder. A comparison of nutrient intakes between a Ft. Riley contractor-operated and a Ft. Lewis military-operated garrison dining facility. USARIEM Technical Report No. T/2, 1987.

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MILITARY
NUTRITION RESEARCH DIVISION

ABSTRACTS:

Askew, E.W., G.M. Hashiro, J.R. Claybaugh, and S.A. Cucinell. Carnitine excretion during exercise at altitude: Influence of carbohydrate supplementation. Fed. Proc. 46:1014, 1987.

Bayerl, C.A.T., A. Weiss, and E.G. Szeto. Nutrition services profile for children in early intervention programs. Outlooks for Tomorrow. American Dietetic Associations Abstracts. pp. 74, 1987.

Neufer, P.D., A.J. Young, M.N. Sawka, and J. Buchbinder. Influence of skeletal muscle glycogen on passive rewarming after hypothermia. Med. Sci. Sports Exercise. 19:44,1987.

Rose, M.S., C.S. Houston, C.S. Fulco, G. Coates, D.E. Carlson, and A. Cymerman. Operation Everest II: Nutrition and body composition. Fed Proc. 46:1335, 1987.

Schnakenberg, D., D. Carlson, S. Deems, R. Popper and E. Hirsch. Validation of a visual observation method for nutritional evaluation of food service systems for military populations. Fed. Proc. 46:875, 1987.

Sharp, M.A., E.W. Askew, and K. Reynolds. Effect of 30 days of caloric restriction on isokinetic strength, body fat and lean body mass in non-obese men. Journal of Applied Sport Science Research. 1:55, 1987.

PRESENTATIONS:

Askew, E.W. Carbohydrate supplementation and physical performance of soldiers at the summit of Mauna Kea. AMSC postgraduate short course, Walter Reed Army Institute of Research. Washington, D.C., April 1987.

Askew, E.W. Carnitine and lipid metabolism during physical performance. AMSC postgraduate short course, Walter Reed Army Institute of Research. Washington, D.C., April 1987.

Askew, E.W. HPLC applications to carnitine determinations. Waters Associates. Milford, MA, May 1987.

Askew, E.W. Nutritional assessment of special operation soldiers consuming the Ration, Lightweight for 30 continuous days. Committee on Military Nutrition Research. Natick, MA, December 1987.

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MILITARY
NUTRITION RESEARCH DIVISION

PRESENTATIONS:

Askew, E.W. Nutrition and performance at environmental extremes. USARIEM Course in Current Concepts in Environmental Medicine. Natick, MA, May 1987.

Rose, M.S. Effects of a NBC nutrient solution on physiological and psychological status during sustained activity in the heat. NATO Nutrition Meeting. Natick, MA, November 1987.

Rose, M.S. Effects of a NBC nutrient solution on physiological and psychological status during sustained activity in the heat. Natick/Chemical School Semiannual Review. Natick, MA, December 1987.

Rose, M.S. Effects of a NBC nutrient solution on physiological and psychological status during sustained activity in the heat. National Research Council Military Nutrition Committee. Natick, MA, December 1987.

Rose, M.S. Operation Everest II: Nutrition and body composition. Federation of American Societies for Experimental Biology. Washington DC, March 1987.

Samonds, K., T. Dugan, M. Sawyers, C. Walsh, B. Wenzinger, and D. Schnakenberg. Recent advances in computerized technologies for dietary assessment of military populations. Invited presentation to Third Conference for Federally-Supported Human Nutrition Research Units and Centers. Bethesda, MD, 24-25 March 1987.

Schnakenberg, D., D. Carlson, S. Deems, R. Popper, and E. Hirsch. Description and validation of new dietary methodologies for nutritional evaluation of military rations and food service systems. Invited presentation to Third Conference for Federally Supported Human Nutrition Research Units and Centers. Bethesda, MD, 24-25 March 1987.

Szeto, E.G. A comparison of nutrient intakes in a Ft. Riley contractor-operated and a Ft. Lewis military-operated dining facility. Mary Lipscomb Hamrick Research Course. Leesburg, VA, August 1987.

Szeto, E.G. Results of the concept evaluation program of the combat field feeding system (medical). USARIEM Course in Current Concepts in Environmental Medicine. Natick, MA, May 1987.

Szeto, E.G. A comparison of nutrient intakes in a Ft. Riley contractor-operated and a Ft. Lewis military-operated dining facility. NATO Nutrition Meeting. Natick, MA, September 1987.

MILITARY
NUTRITION RESEARCH DIVISION

KEY BRIEFINGS:

Eldon W. Askew, LTC, Ph.D. Combat Field Feeding System (CFFS) testing plans; MG Drummond CG, OTEA, Natick, MA 1987.

Eldon W. Askew, LTC, Ph.D. Ration Testing Program and Budget; LTG Ross, the DCSLOG, Natick, MA 1987.

Eldon W. Askew, LTC, Ph.D. USARIEM Program of Military Nutrition Research; LTG Becker, the Surgeon General of the Army, Falls Church, VA 1987.

Eileen G. Szeto, CPT, MPH. A Comparison of Nutrient Intakes in a Ft. Riley Contractor-Operated and a Ft. Lewis Military-Operated Garrison Dining Facility; ODCSLOG sponsored MACOM Worldwide Nutrition Conference, Fort Lee, VA March 1987.

Eileen G. Szeto, CPT, MPH. A Comparison of Nutrient Intakes in a Ft. Riley Contractor-Operated and a Ft. Lewis Military-Operated Garrison Dining Facility; Armed Forces Product Evaluation Committee Meeting, USANRDEC, Natick, MA April 1987.

SIGNIFICANT TDY:

Eileen G. Szeto, CPT, MPH. To attend Army Nutrition Planning Committee Meetings, Ft. Lee, VA, 4 March - 6 March 1987.

Eileen G. Szeto, CPT, MPH. To attend Army Nutrition Planning Committee Meetings, Washington, D.C., 15 March - 17 March 1987.

Eldon W. Askew, LTC, Ph.D. To attend a Personnel Management for Executives 10 day course, Tamiment, PA, 1 December - 11 December 1987.

Eldon W. Askew, LTC, Ph.D. To present Research Opportunities at USARIEM to AMSC Mary Lipscomb Hamrick Research Course, Leesburg, VA, 9 August - 14 August 1987.

Eldon W. Askew, LTC, Ph.D. To brief the Surgeon General of the Army on Nutrition Research, Falls Church, VA, 12 October 1987.

Eileen G. Szeto, CPT, MPH et al. Conducted Concept Evaluation of Army Medical Field Feeding System study, Fort Sam Houston, TX, January 1987.

Eileen G. Szeto, CPT, MPH et al. Conducted garrison dining facility study, Fort Devens, MA, September 1987.

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SIGNIFICANT VISITORS:

Army Nutrition Planning Committee - 16-17 June 1987.

Major General Drummond, CG OTEA, Falls Church, Virginia.

Dr. Robert Moore, Chemist, USDA Human Nutrition Research Center, Grand Forks, ND.

Lieutenant General Ross, DCSLOG, Washington, D.C.

Dr. Robert Neshiem and members NAS/NRC Committee on Military Nutrition Research, December 1987.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Eileen G. Szeto, CPT, MPH. Member Army Nutrition Planning Committee.

Eldon W. Askew, LTC, Ph.D. Guest reviewer for American Journal Physiology and Journal of Applied Physiology in Exercise and Lipid Metabolism.

Madeleine S. Rose, MAJ, Ph.D. Awarded Additional Skill Identifer 8I (Clinical Nutrition Specialist).

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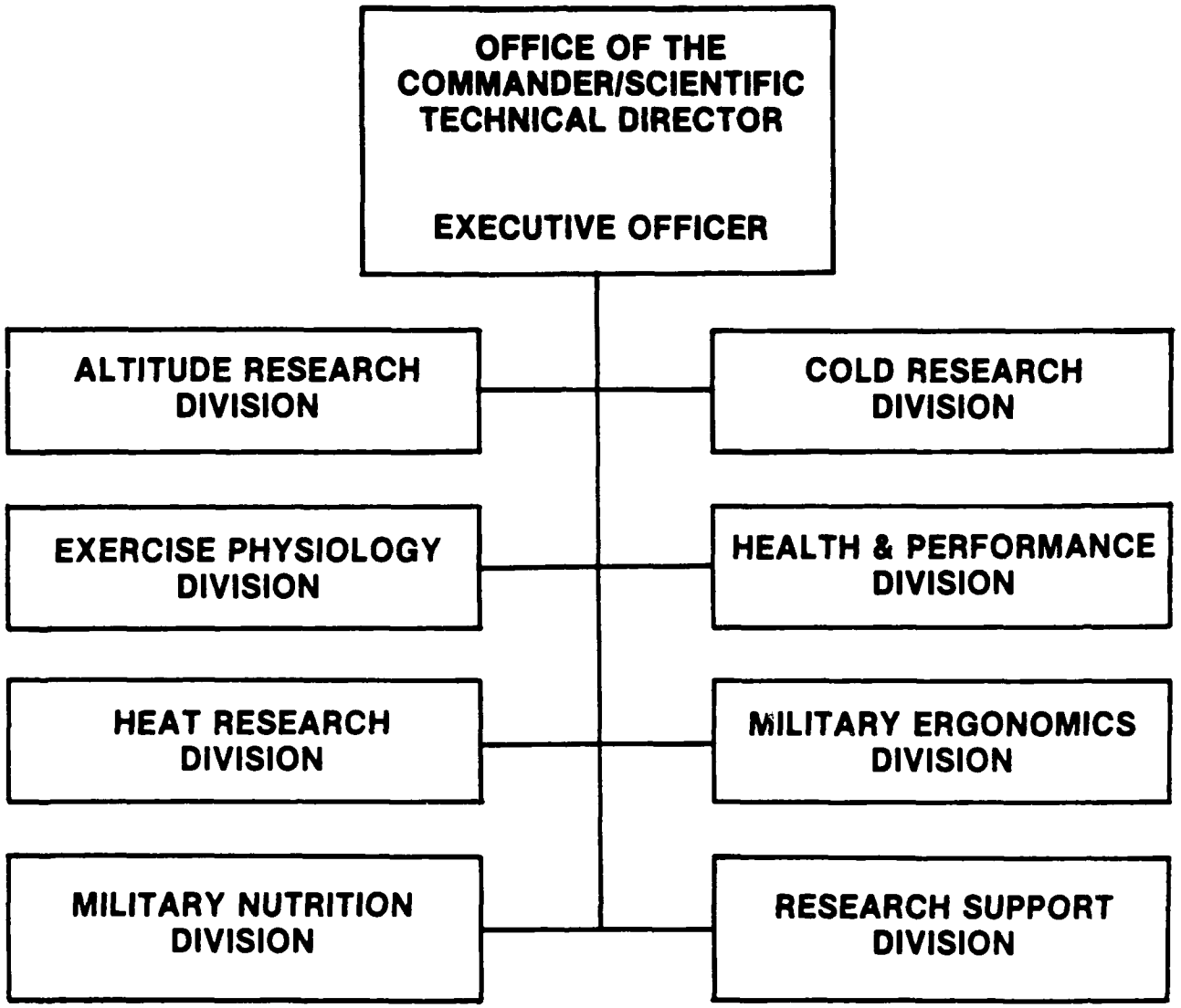

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